MACHINERY.

VOL. 2. February, 1896. No. 6.

SOME SPECIAL FEATURES SEEN IN BRITISH WORK SHOPS.

JOHN E. SWEET.

IN response to your repeated solicitation to write of my observations while in English and Scotch machine shops, I comply with great hesitancy, because I can see no advantage in saying anything about what seems to be inferior to our own practice, and so far, whenever I have told of the things that seem to me worthy of praise, it has always led to a hot water discussion, and many times the loss of friends. I certainly shall not deviate, however, from the first idea above expressed.

Although I was in Manchester a day, I failed to see any of the wonders there, because those of my acquaintances whom I remembered there were away, and as I had no letters, supposed that application to any of the work-shops without would be useless. Later I found that the English readers of American mechanical papers were numerous enough to have made my name a passport to the most of the places where I would have cared to go. This leads me to make another of the hot water remarks, and it is this: that I think of all the civilized countries, there is none where the mechanics know so little about what is done in other countries in the mechanical line as we do, and this comes from two causes—we think we are the leaders in all things mechanical, and hence it is not worth while to know what others are doing, and they also think we are the leaders, and that it is worth their while to know all about it. This in a sense is complimentary, and another thing to our credit is that it is easier for a stranger to see what is done here than in other countries.

John E. Sweet

At the works of John Lang & Son, at Johnstone, Scotland, they make it their business to build lathes, and one feature is that the bed is a box casting which goes to the floor, and when such a casting is a complete box, it is a good form in which to put the metal.

About all mechanics are beginning to believe that cast iron in a machine pays good interest on the cost, and there can be but one question as to which is the best form to put it, whether in a box section of the largest size possible, which is the stiffest form practicable, or in a plain square solid beam as suggested by Oberlin Smith, which embodies the anvil principle in its most complete form. The beam will sag by its own weight the most or as much as any form of any weight, and there is but one advantage, it may be the best to prevent chatter.

John Lang & Sons have a quick change of feed to their lathes that they have been using for years, which we ought to have stolen long ago; I also found there the quick stop and reverse for radial drilling machines, which I had been advocating for several years, and finally had to make for myself, and was rather taken back to find not only that, but that worm gears for rotating the arm of radial drills are old and not uncommon. After two or three years' experience with the quick stop and reverse, I am of the opinion that it is quite as valuable an improvement on a drilling machine as the quick return, and in large radial machines a worm gear adjustment for the arm must be a consolation to the operator.

One thing that particularly attracted my attention about the Scotch lathes was that the workmen could not use a fine feed, nor did they appear to want to, for they seem to shift the lever from $\frac{1}{32}$ inch to $\frac{1}{4}$ inch feed, where they could without being told.

In the works of the Southwestern R. R. Co., at Nine Elms, London, many things were seen that were new and a surprise. Whatever one tells about locomotive work, if he is not a locomotive engineer, is likely to be wrong, at least in the eyes of the locomotive engineer, and in this connection I have an apt story to tell:

Their locomotive tenders are divided differently from ours. Our tenders are fixed for holding coal in the middle, and have the water tanks around the outside. In the case of the one I saw there at least, and I think common, the water is at the bottom and the coal on top, and the partition or floor between the two, high at the back, and about a foot above the footplate; the object being to have the coal naturally work forward and be easy for the fireman to handle the fuel. That appeared to me to be a good scheme. In mentioning the fact to an accomplished Western engineer, he said it would not do in this country at all On asking why, he said: "Because you could not carry half coal enough" This was the first time that I was dead sure I had too much mathematics for my own good.

The fire-doors of English locomotives open like sliding doors, or two sliding doors in fact, so pivoted and linked that one handle opens both. This handle is convenient to both the fireman and engineer, so that in hard work the engineer can open and close the door for the fireman with his left hand, and without looking; with this advantage helping the stoker and helping the fire, as the door is kept open but a second. This sliding door cannot be blown open when a flue gives out. Whether there may not be some reason why this door would not work in America, I do not know. Thirty years before point switches were used here, they were universal in England, and a valid reason given why they would not work in our ice and snow, and yet point switches are common here now. Perhaps thirty years more will show that coal will slide down hill, and that sliding doors will stay shut the same in one country as another.

At the Nine Elm Works, where not only the repairs of the engines of the system are made, but the new locomotives as well, the assistant superintendent paid three or four of us Americans

one of the highest compliments I ever received by spending at least four hours showing the most of what there was to be seen.

Locomotive boilers made tight without calking, in fact a boiler shop where both drift pin and calking tool were prohibited was a new thing to me, as was the whole boiler construction. Shell joints that give 80 or 90 per cent. the strength of the sheet in place of 55 to 60, circular joints butted together and covered with a band shrunk on, and heads riveted to solid rolled angle hoops shrunk on with all holes drilled in place, seemed like a machine job, rather than that of boiler work. As one of the engines that had just come in from its run was over thirty years old, it would seem that with the Southwestern they found good work worth its cost.

It will likely take the British engineers as long to be convinced that the forged locomotive frame is better than the plate one, as it has our railroad men to be convinced that there was merit in the block system. The plate frame being such an easy thing to make, and filling apparently every requirement when it is made, gives a good deal besides prejudice to overcome before they will be convinced.

At the Nine Elm works their facilities enabled them to pile ten plates top of each other with a template on top, follow around the template with a slotting machine, cutting the pile into shape, and, without unpacking, run under three radial drills and drill all the holes without moving. In this way the frames for five locomotives are finished in a lot, and all alike within the allowable limit or error.

A milling machine carrying two mills 8 or 10 inches in diameter by about a foot long, slabbing two connecting rods at a time appeared to be a dozen years old, and a machine for grinding the slots in case hardened links to the proper radius, and another one grinding the two end holes perfectly without revolving the links were as good pieces of devising as one can see anywhere.

First an emery wheel, mounted on a high speed spindle, was caused to travel like a planet within the holes, so far, that was easy enough to do, but in addition, the wheel could be set out as the stock and wheel were ground away, and that while under motion as easily as an ordinary wheel is set up to its work, the wheel traveling back and forth to keep the holes parallel.

The English seem to make a distinction between forging done by machinery and that done by hand, the former being called "forging" and the latter "smithing." Special pride is taken in the amount and perfection of the forging, pieces of all shapes being smashed into shape ready for the milling machine without any hand work whatever.

Casting the two cylinders in one casting is the practice; a double boring machine used to bore both cylinders at once; and as the two valve chests are between the cylinders (the valve seats are not over 4¼ inches apart), a special milling machine is made to stand on its head, go down between and dress the faces and ports. How often we hear it said, "this is the country where the milling machine was developed," and the impression conveyed that comparatively little is done in other countries. Such a conclusion can easily be reached if one will only go in the right shop here and the wrong shop abroad. On the other hand, the reverse conclusion would be reached if the searcher for facts should go into the works of Alfred Muir in England, and in the shops of Tom, Dick and Harry here. I have been told by Americans that in no other shop in the world, not even in the Steinlen works at Alsace, can such a variety of milling machine work be found as in Alfred Muir's works at Manchester. I give this second hand, but have no reason to question its truth.

At the engine works of Willans & Robinson, Thames, Ditton, two wonders await every American, except those who will not admit that anything can be done except what we do. There are a number of features about the engine that students in engineering have been taught to believe are contrary to the best practice, but experience shows that they produce the results, and the style of the engine renders good work necessary, and the good work produces results where it would be wasted on other designs.

The cylinders and steam chests are piled up one above another, and it is important that they be true and in line. These cylinders are bored, reamed and faced on an ordinary lathe, a regular English lathe, with no fixtures except a holder attached to the slide rest to carry the reamer, that is, the reamer is held and driven through the work by the slide rest and not by the tail stock. Mr. Eaton Shore (the works manager who, as well as every one connected with the company, gave me every attention, all information and every opportunity possible to see and learn), is firmly of the opinion as I am now convinced that the results obtained could not be continuously produced by the tail stock feed. As an example: a half dozen cylinders some 14 inches in diameter and a foot or so deep, with a flange outside at one end and inside at the other, were by the lathe just finished. One taken at random was sent to the testing floor and placed on an oiled surface plate. The testing plug, made like a web pulley with about 2½ inches face, was started in the cylinder and crowded down until about even at the top, when with a finger on the top at one side, the plug was shown to be so free from contact with the sides of the cylinder as to spin around like a top. The man then stood upon the plug, and it carried his weight on the air. This job probably could be done in any good shop if one went at it the right way, but for one thing the castings are made of re-cast pigs, re-cast after the mixtures are made. This makes a uniform iron which is more likely to keep its shape, but is very hard and that makes the work difficult, such hard cylinders and the accuracy contributes to the success of the engine, but such accuracy would be of no particular advantage in an ordinary engine when the cylinders are distorted by steam in one place or on one side, and exhaust in another.

The Willan's engine is in its design, workmanship and method of construction so dependent one upon the other, that it is not easy to describe how things are done, and give them their due force without describing the engine itself, and the whole would be more than a single article would cover, and I find that I must leave it. They have in use what I understand is a common thing, a flexible copper steam pipe, capable of resisting any required pressure, that bends around like a rubber hose. Not a double wire arrangement like Almond's, depending on mechanical fits, but an absolutely tight copper pipe constructed in such shape as to be easily bent around; an ideal device for an erecting floor.

It is useless to attempt a description of the interesting and wonderful things to be seen at the works of the Willans & Robinson Co., and to one who appreciates wonders some such thought as this must come to him— the death of a great engineer is a loss to the world. When Peter William Willans died, the world lost a genius.

* * *

THE STEAM ENGINE.—2.

HEAT, STEAM AND CYLINDER CONDENSATION.—COMPOUND ENGINES.

F. F. Hemenway.

CHIMNEY DRAUGHT.

Chimney draught results from the difference in the weight of a column of rarified gases in the chimney and an equal column of external air. It will be readily seen that the heavier air outside will force its way into the chimney, furnishing oxygen to the fuel. Some writers say that the most coal can be burned in a boiler furnace when the temperature of the chimney gases is 600°, while others vigorously dispute this. Whichever is right, it is advisable to keep the gases at a temperature considerably lower than this.

THE BOILER.

In considering any steam plant we naturally enough come first to the boiler or boilers. It is here that the operation of getting motive power from coal begins. From here the heat from the furnace is carried, by the steam, to the engine cylinder, turning around the engine shaft and all connected with it; and it is here that loss first begins. Suppose the construction is good, there will be losses in operation. These losses come in various ways. Some of the heat passes up the chimney. This heat may amount to 25 per cent. of the total heat in the coal, but if the escaping gases can be kept at a temperature considerably below 600 degrees as will be the case if the boiler capacity is ample, there will be less loss. Then some of the fine coal is lost through the grate, some heat is lost by radiation, and there is some loss by imperfect combustion. Thus if all the coal is burned to carbonic acid, combustion is complete; but if any of it is burned to carbonic oxide, all that is so burned yields less than one-third of the heat that it would if completely burned. To remedy this, or with a view of doing so, air is sometimes admitted over or beyond the fire to burn the carbonic oxide to carbonic acid. It is a delicate operation, for it is manifest that if more than enough air is admitted it will carry away heat.

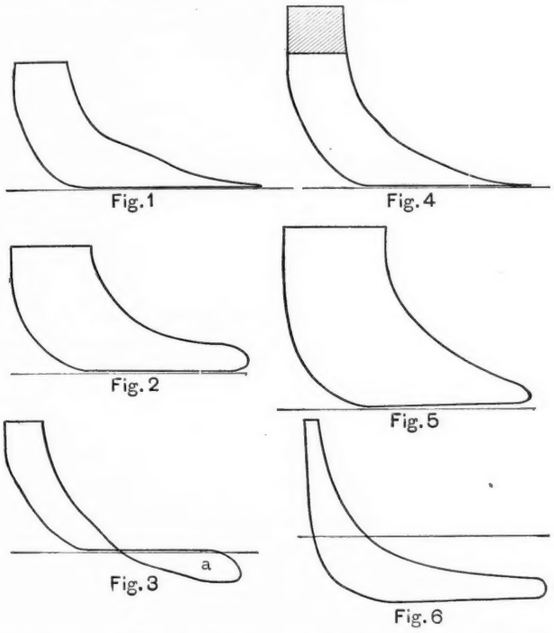
It may be assumed that one pound of good coal will yield 14,000

heat units. If of these 70 per cent. is utilized, it is all that need be expected. It is more than an average, but should not be.

After the steam has left the boiler it can, under ordinary circumstances receive no further heat. There is nothing but loss of heat, resulting in condensation. There is some loss from the steam pipes, but as they are usually short and protected, it is not serious. The steam, as it leaves the boiler, contains a large amount of latent heat. Thus, if steam of 100 pounds pressure, absolute, is carried, there has disappeared 883 heat units. It has, so far as we are concerned, actually disappeared. The temperature of the steam is only about 327 degrees, and that is the temperature of the water from which it is generated. The amount of heat in the steam not accounted for by the thermometer was early called latent or hidden heat. Where or in what way this heat, this great amount of heat—the latent heat—disposes of itself in the steam, is not clear. It is known to be present, because if the steam is condensed it will manifest itself by the amount it will raise the temperature of the water used to condense it. Some reason that the latent heat of steam may be constantly employed in agitation—moving—the atoms or particles of steam; that it exists in this form of motion, hence cannot appear as temperature; but this is supposition only.

There is a little loss from condensation from the steam pipe, and though this should not be so, some water is likely to be carried over from the boiler. This should be separated from the steam, near the engine.

The great loss of heat occurs in the engine cylinder. When the steam from the boiler enters the cylinder of the engine, it meets with surfaces that have been exposed to the chilling effects of the



atmosphere, or the condenser, and is condensed with great rapidity, parting with much heat, in some instances amounting to 50 per cent. of the heat in the steam, and with any form of automatic cut-off engine, is seldom less than 20 per cent. It seems—such a loss as this—enormous; it is enormous. Then a large amount of heat goes to the atmosphere or condenser. It is a loss of heat from the boiler on. A small percentage of the heat only is used for useful purposes in the best of engines.

This condensation to warm up the cold surfaces of the cylinder is a great drawback to economy. As the cut-off is shortened it becomes a greater percentage of the useful work, so that an engine may easily cut off too early, notwithstanding the advantages of expansion. With modern steam pressure, expansion should not be carried to the atmosphere by from five to ten pounds, depending upon circumstances, that is in a non-condensing engine; and in a condensing engine to about half way between atmosphere and vacuum.

In the rough sketch, Fig. 1, sketched to no scale, it would be better if there was more load on the engine, or if there was a smaller cylinder, producing in either case a diagram like that rather wildly indicated by Fig. 2.

If expansion is carried farther than in Fig. 1, then a loop appears as at *a*, Fig. 3, which is manifestly a waste. This loop represents negative work and a loss of heat. It is heat that we must look after all the time.

HIGH PRESSURE STEAM.

The economy of high pressure steam is pretty generally understood, and it is well to note that if the steam is expanded too low, as in Fig. 1, it will be economy to raise the pressure if it is not already quite high. There seems to be a limit in this respect, but it is beyond any pressures carried in ordinary practice. If the steam pressure as in Fig. 1 were increased as in Fig. 4 (shown by the part shaded), there would be a gain, notwithstanding expansion is carried too far. This gain would come from the higher steam pressure, and not from low expansion. The loss from too low expansion is more than overbalanced by the higher steam pressure. In this case it would be still better economy to increase the load or reduce the diameter of cylinder, so as to produce a diagram as in Fig. 5.

In designing and operating a steam plant, good, reliable, lasting and construction economy of fuel should, without much consideration be yoked together. Sometimes their relative importance will differ, and this must be looked after. The engineer must know his part in these things, and the designer must know his. Waste in operation can only be traced by complete and persistent observation, and the same is true of design. Not much can be learned from building engines to go broadcast, as it were, and never know anything of their performance.

On the part of the engineer, all coal burned under the boilers should be weighed and noted, day by day. The indicator should be frequently applied. The water supplied to the boiler should be frequently weighed, and comparison made with the coal burned. In the event of making any changes in boiler or engine, it is important to know the effect of that change. For this purpose careful observations should be made both before and after the change.

If this weighing of coal and water were more common there would be better boiler efficiency. Priming, when it becomes more than common, should be looked after and the reason fer reted out.

The quality of steam as it goes from the boiler—is it wet, dry, or superheated—should be frequently ascertained. It does not pay to heat water up to between 300 and 400 degrees and then throw it away. It would be advantageous if steam were slightly superheated, but with the majority of boilers, if dry steam is had, it is fortunate. Much water in the steam is not to be tolerated. Boiler, steam pipe and cylinder, being protected from external radiation, the engine must take care of the rest.

COMPOUND ENGINES—CONDENSATION IN THE CYLINDER.

The compound engine has forced itself into public favor. It was early attacked, and quite persistently, by eminent engineers, and stumbling blocks were thrown in its way; but it went along, rather slowly perhaps, but rather surely. "What is the use," would ask its engineering enemies, "in suffering the loss from condensation in two cylinders, when one of them will do as much work as both?"

The argument of those who favor compounding is that the loss from condensation is less in the two cylinders than in one, but writers on this subject seldom or never give any reason for this that can be followed.

Let it be assumed that a two-cylinder compound has cylinders whose ratio is one to four, and that the surfaces that affect internal condensation are also one to four. Now the fall in temperature should be the same in each cylinder. Let the total fall in temperature be, say, 324 degrees. From this subtract the temperature of the condenser, say 110 degrees; $324-110=214$ degrees for the drop in both cylinders, or $214\div2=107$ degrees for the fall in temperature in each cylinder.

It is not practicable to determine the exact amount of condensation in each cylinder of a compound engine, but we may conclude without serious error that it varies as the difference between the initial and final temperatures in any cylinder. As this is the same in each cylinder, we may take the condensation to be as the exposed surface in each cylinder, and we can represent (not measure) this by multiplying 107 by 1 for the high pressure cylinder and by 4 for the low pressure cylinder, $107\times1=107$ and by 4, $107\times4=428$. Adding these two amounts together we have $107+428=535$, which is simply a figure for the purpose of comparison.

Now we know the low pressure cylinder of a compound engin.

is supposed to be capable of doing all the work of both cylinders. Then we should have all the fall of pressure in one cylinder, the one in which the condensing surface is represented by 4. The total fall is 214 degrees, and $214 \times 4 = 856$ as a figure *representing* the condensation in a single cylinder against 535 by compounding.

According to this, if in the single cylinder the condensation is 40 per cent., in the two-cylinder compound it will be 25 per cent. of the steam admitted.

I have before me at this writing a diagram from each of the cylinders of a two-cylinder compound, in which the total expansion is twenty-fold. Now in a diagram like Fig. 6, which would correspond to that from the low pressure cylinder when at the same expansion—the steam pressure is, at engine, a little more than 151 pounds absolute—how much useful work would be done under full steam, that is, up to the point of cut-off? Probably but very little would be done until somewhere along in the cut-off, when the pressure had fallen materially by expansion. It would be highly impracticable to do this work expanding twenty times, in the single cylinder engine.

The compound engine has come to stay. If, as it is said, it will save 20 per cent. in fuel over the single cylinder engine, its progress should be more rapid for stationary purposes, as it seems to be. Less pressure on the pins and main journals is important in itself, and must leave more of the total work to be utilized, besides giving better turning. It costs more to build and probably more to keep in repairs, but not so much so as might be expected. To partially offset this, especially in a large plant, less boiler capacity is required. Against this, it may be said, perhaps with some truth, that the pressure will be higher than the single cylinder engine, and the boilers must be stronger, and hence more costly per unit.

There are those who believe the saving by compounding to be materially more than 20 per cent. in fuel, if tested against a single cylinder engine in good condition. The truth is any new engine, whether simple or compound, is usually tested against some dilapidated specimen that is about to be thrown out because it is worn out. A single cylinder engine, upon which the ravages of time and constant use are held up by ancient construction, has no show against a new compound that supplants it. This is not saying that the compound engine is not better, economically, than the single cylinder. It has reference as well to single cylinder engines, one new and the other old. The compound engine needs no false bolstering.

At the present time, triple expansion and quadruple expansion engines are used quite extensively, although the use of these types of engines, particularly the latter, is more common in many parts of Europe than in this country. It is claimed that there is considerable economy in these engines where very high pressure steam is employed and the engine is properly proportioned to its work. As against this, however, there are those who claim that about all that can be had from any compound engine can be had from the two-cylinder compound, if the arrangement is properly made. This seems doubtful, though it may be true. We shall all know more about it later on, and perhaps instead of four cylinders, six may be used. There is yet a good deal to be dug out in relation to compounding.

My first acquaintance with a compound engine was at William Coutie's, Troy, N. Y. I could never conclude to whom the engine really belonged. It was this way: Mr. Coutie was building a small machine shop, or enlarging his old one. He would be in need of an engine. Across the narrow street from Mr. Coutie's was a mill operated by a non-condensing engine. Mr. Coutie was a firm believer in compounding, so he proposed to the mill owners to build a low pressure engine, place it in his shop, and pipe their exhaust across the street and use it in his low pressure cylinder, guaranteeing not to increase their back pressure. The back pressure was not increased, and Mr. Coutie continued to use his part of the compound engine successfully, for a good many years. In fact, he used it until slack work at the mill interfered with the arrangement.

* * *

AMONG THE SHOPS.

F. E. REED CO.

Those not acquainted with the New England States would be surprised to find the large number of shops building regular lines of machinery, and with few exceptions these are what would to-day be termed small shops.

Worcester, Mass., is full of material to interest the mechanic, and here is the home of several of the well known machine tools of the country. The shop of the F. E. Reed Co. is thoroughly modern and contains much that reflects credit on Mr. John Bach, the superintendent, as well as the firm. System is evident on every hand, from the turning of handles and similar work to the finished lathe. The small parts or "trimmings" are kept in a stock room, in quantity, being made in large lots and drawn from as needed for the completion of the machines. These are made by apprentices as a part of the work needed to fit them for good workmen later on. On other parts, requiring nice fitting before using, the boys get them in shape and leave just the "finishing cut" to be taken by the journeyman. This gives the boys good practice in machine work and is satisfactory to all concerned.

Milling has been adopted for some parts of the work, though not as extensively as in some shops, but its uses are appreciated, and it will doubtless be increased as fast as seems advisable. One plan used by Mr. Bach for the first cut in milling out the pockets for lathe-head boxes is shown in Fig. 1. An end mill shaped about as shown, is run through, which surfaces the bottom very nearly to size. The gang cutters then trim down the sides and give the bottom the finishing touch. The object is to prevent the gang mill from striking such a solid mass of metal, causing it to jump and spring (to a small extent) and not giving as good results as the plan adopted. A very ingenious method of securing good results in babbiting a box is shown in Fig. 2. After being bored to the correct diameter it is dovetailed as shown, and this makes an excellent means of holding firmly the babbit lining, as there is a clean surface presented to the babbit to be poured into. These dovetails are cut in a key-seating machine, at a minimum

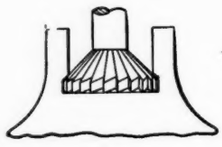


FIG. 1.

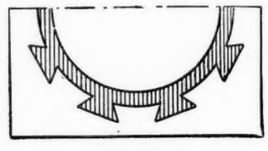


FIG. 2.

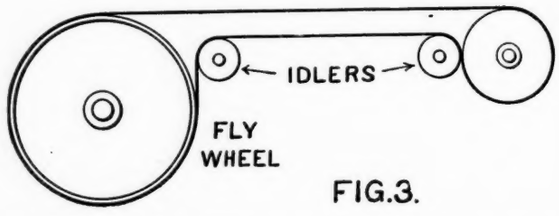


FIG. 3.

cost, each dovetail being made at one cut. There is something of a novelty to most machinists in the transmission line in this shop, although it is not entirely new, and has been used elsewhere. The system consists of simply increasing the adhesion of the belts by increasing the contact between belt and pulley, instead of by abnormal tension of the belt. Fig. 3 will give an idea of this method, which can be applied to advantage in many if not most cases. Belts are not strained, but are simply persuaded to hug a large proportion of the circumference of the pulleys, which gives an increased driving power. In the case of their main belt, one 7 inches wide is now doing the work of an 18-inch used in the regular manner, which speaks very highly of the driving power to be obtained from belts used in this manner.

Great care is given to details, and when in the assembling of machines it can be depended on that parts will fit where they should, the care is well bestowed.

A very handy scraping and fitting table is used here, which is a hollow column something like a grinder, and a swiveling top which permits of moving the work into any position for better light or for other reasons, although it can be clamped rigidly if desired, or just enough to permit moving by a little extra pressure. They are very convenient indeed, and this means that they are economical. Many other interesting details must be omitted for lack of space.

PRENTICE BROS.

The shop of Prentice Brothers is also of the modern type, their production of drills being particularly well known. The shops are light and convenient and equipped with modern machinery. The milling machine is in great favor here, and the man who had

them in charge was very enthusiastic over them and their work. Here nearly the whole of a lathe-head is milled, the ways which fit the Vs of the head, the pockets for boxes, the boxes and the caps which hold them in place. These are milled in the regular way by a gang of cutters on a horizontal arbor. A new addition to the milling machine group, which was just being started on surfacing and similar work, was a Becker vertical miller, and it seemed well adapted for much of this class of work. The use of a vertical spindle for a large variety of work is being recognized, and while the fact that the universal milling machine has the advantage in certain lines of work such as tool rooms and similar places, cannot be disputed, the writer believes that this form of machine will be more widely adopted as its merits and possibilities become better known; or, it might be said as the different conditions which govern the milling of work and the action of milling cutters are better understood. One of the largest drill-presses for regular use that the writer knows of, was made by this firm for the Pittsburg Locomotive Works, and several of a somewhat smaller size were under way at the time of my visit.

THE BULLARD MACHINE TOOL CO.

The Bullard Machine Tool Co., of Bridgeport, Conn., have built up quite a line of fairly heavy tools. Their boring-mill table is supported on a steel step, which is ground to the Schiele curve for the bearing. The largest diameter of this bearing being over half the table diameter, gives a substantial support, and the lower end of the step forms a large vertical bearing which insures steady running. A nut and collar on the bottom takes care of any lifting tendency of the tool in the work. These steps are placed in position and then the babbitt poured in place, securing the same contour of bearing as the step. The tables are turned off in place on each machine, and then a boring-bar fastened to center of table and the holes for boring-bars in the heads on cross rail are then bored in place, insuring their alignment with the table.

On their heavy lathes (and they nearly all deserve that name, for they realize that plenty of cast iron in a machine tool is a good investment) they are building a chuck into the face-plate, which makes a very substantial arrangement, and one which is giving satisfaction to their users. They build a lathe with a substantial turret on the lathe-carriage, which is extensively used in large valve works, the Chapman Valve Mfg. Co. having one or more in regular service.

They are building a new line of three-jawed independent chucks which is very substantial and convenient to operate. The jaws are made as shown in Figs. 5, 6 and 7, and after setting to the required size, only the jaw A is moved, a plan often adopted by lathemen with ordinary chucks. The construction is shown in the right-hand sketch, the body of the chuck being counter-bored for the flange F of the screw, the counter-bore threaded to receive the hollow or ring-nut D D which forms the thrust-bearing for the collar of screw when being tightened against the work. The nut is turned by a forked screw driver in slots shown at D D, a square key-wrench operating the chuck screws.

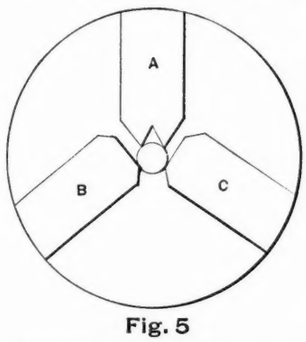


Fig. 5

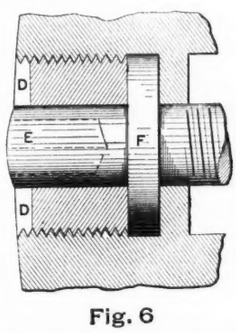


Fig. 6

Another feature for large screw work is the reversing die, which saves reversing the lathe, making a gain in time in most operations of the kind. For this work they have a two-speed countershaft, and in addition have a neat clutch in the lathe-cone for throwing the back gear in or out at will. This saves more time in a day than seems possible to one who has not studied the operation of machines with and without this attachment.

They are fitting up their erecting floor and shop for heavy work, and they were installing a large Detrick & Harvey open side planer at the time of my visit.

One of the vertical milling machines was being used to mill the inside of hand-wheels between the arms, as shown in Fig. 8. This cleans it out nicely, leaves the inside of the rim smooth and conforms to the circle of the rim. They are trying a new lubricant for their screw machines, which consists of a special oil mixed with several times its weight of water, and having a very

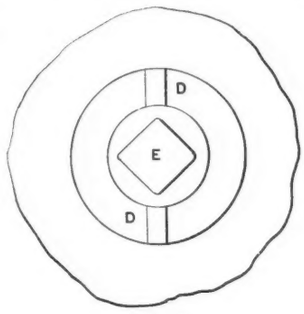


Fig. 7

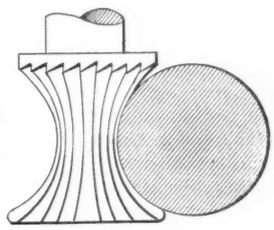


Fig. 8

white appearance. It is giving just as good satisfaction as lard oil and costs about one-twelfth as much—quite a saving where large quantities are used, as in screw cutting. It is said to be similar to the oil often used in marine work for keeping the bear ings flooded.

* * *

MODERN DATA ON THE PHENOMENA OF SLIDING SURFACES.—2.

JOHN H. COOPER.

The writer, having "taken a hand" with the inventor in the development of the Holmes fibre-graphite bearings, came to a most remarkable discovery. The statement was mentioned, following certain trials that had been made, that no wearing of the shaft journals had as yet been observed, and very little abrasion or wearing away of the bearings had been reported by those who had used them. The reason for this may be thus explained: During the first revolution of the shaft, its cavities are filled with graphitic particles, which are worn off the bearing by the rubbing action of the shaft upon it.

When the surface of the shaft is completely covered and evened up upon its whole exterior, the sliding thereafter will be conducted wholly upon the newly-formed graphitic surfaces, to which also the disengaged particles of the bearing will assist in the lubrication. Friction will in consequence be reduced to a minimum, and the shaft journal will be protected from subsequent wearing.

The above paragraphs are interjected here to give a parallel effect by what is known as *integral lubrication*, an expression of Dr. Stuart Gwyn's, which he employed for describing the effect of a lubricating element which is itself an integral part of the surfaces in contact.

In the discussion one member said: "It was well known from practical experience that with a constant load on an ordinary journal it was difficult and almost impossible to have more than 200 pounds per square inch, otherwise the bearing would get hot and the oil go out of it; but when the motion was reciprocating, so that the load was alternately relieved from the journal, as with crank-pins and similar journals, much higher loads might be applied than even 700 or 800 pounds per square inch."

Furthermore, the discussion brought out the existence of the converse to the floating surface-plate theory, which it is well to note: "It was very easy indeed to get rid of that film of air, and then the plates stuck together." As much as forty years ago (now fifty) a member had found out that it was easy to make the slide-blocks of locomotives too long, because the leading part of the blocks then swept away the oil, and left the tail part dry. That was obviated by grooving; and within his own knowledge it had been found necessary to groove the journals of axles, as well as their brasses, so that the groove in the journal might have a chance of picking up the oil as it passed, and of carrying it from the bottom up into the bearing or from groove to groove in the brass.

The scraping of the flat surfaces has advantages of lubrication; it is possible without it to have "too good a fit." "There were very many cases of slide-bars and rubbing surfaces of that kind, which worked on for ever so many years before the scraper

marks were gone; then all at once they began to cut, because the scraper marks were worn off;" that is, because the receptacles for oil were obliterated.

Grooves cut across sliding surfaces, one engineer says, makes places for dirt to collect; another says they give freedom of escape for dirt, from the places which should be maintained for perfect lubrication. English engineers cut them for retreating places for the oil while the cross-head is passing, from which it flows upon the guide before the cross-head's return. The writer took kindly to this hint, repeating this little scheme with advantage some eighteen years ago.

"Several years ago, when Mr. Isherwood, of the United States Navy, was testing the power of steam engines by making them drive a number of fans, a doubt was raised as to whether the lubricating value of the lard oil which was used on the fan shaft bearings remained unchanged in its repeated use. When fresh oil was applied, all other conditions remaining the same, the speed of the fans was observed to increase immediately. It would seem, therefore, that in the case of lard oil, and probably of all animal and vegetable oils, the freshness of the oil had a considerable influence upon its lubricating power."

On the other side a member said: "In reference to the life of oil, he had had a carriage running on the Manchester Railway, with brass bearings, which had run about 29,000 miles a year with the same bearings for ten years; and the average amount of oil put in during the whole time was one pint per annum per journal. The journals were lubricated from the bottom."

In the discussion, the statement was reaffirmed that "the axle-boxes in railway trains differed in that they were all in a state of vibration, which probably also allowed the oil to pass freely around. That if the bearing was freely supplied with oil it was more a question of the nature of the oil than of the nature of the metals. The experiments also prove that, as the bearing was entirely oil-borne, the question would naturally be asked, 'Does it really matter what the bearings are made of?'"

When we come to know of the three elements concerning this problem of lubrication—first, the cost of the lubricant, then the fuel cost to furnish the power for overcoming the resistance due to friction and the lubricant, and finally the wearing away and waste of journal and bearing metal, some solid facts and conclusions are discovered which are worth knowing and using, and of these, in so far as railroad axles and boxes are concerned, we have the greatest confidence in what Superintendent Ely, of the Pennsylvania R. R., says:

"The wear of car-axle bearings, approximately, is about one pound of metal worn off for every 25,000 miles the bearing goes. The wear of axles is about one-third as fast."

Introducing other data for comparison of values, a deduction has been reached, which shows the aggregate cost of metal wear of axle journals to be six times the amount of money spent to lubricate them. And again, the cost of the coal burned for overcoming their friction is double the cost of their lubrication.

The bearing of a shaft, to be effective, should permit of a certain amount of yielding to the pressure imposed upon it. This idea is conveyed by the original name of "pillow-block" which has been given to it. Of this quality, Prof. Denton says: "If the brasses are lined with some of the soft anti friction metals, the crushing down of grooves by a smooth journal does not cause excessive friction. Herein lies the true advantage of these metals. The chances of heating are less with soft, anti-friction metal than with bare brass or hard white metal."

Care must be taken not only to effect but to maintain perfect lubrication of bearings. Of this, Prof. Denton says: "Interruption of the uniformity of the intervening film of lubricant between the rubbing surfaces, is a certain and probably the far more frequent direct cause of abrasion." Furthermore, "abrasion may result from the gradual and inevitable variations of smoothness due to metallic wear."

Of course this result is hastened or aggravated by the lack of lubrication or by the use of low quality oils and greases.

The destructive processes due to motion and load do not go on so severely with other machinery. Prof. Denton directs us to the fact that, "in cotton mills the cost of the power is alone to be considered, and in rolling mills and marine engines the cost of the quantity of lubricant used is the only important factor."

We may safely close this article with the declaration that a lubricant that does not lubricate is as money thrown away, and Prof. Denton's maxims amply reinforce it: "Undoubtedly the most important element in lubrication is that oil shall reach every part of the surface.

"Anything that induces oil to neglect to interpose itself between a spot of the rubbing surfaces is a possible cause of overheating.

"Anything that improves the distribution of the oil reduces friction.

"Either directly or indirectly, therefore, the uniformity with which the lubricant insinuates itself between every part of the bearing surfaces determines the success of the lubrication."

* * *

PRACTICAL PROBLEMS.

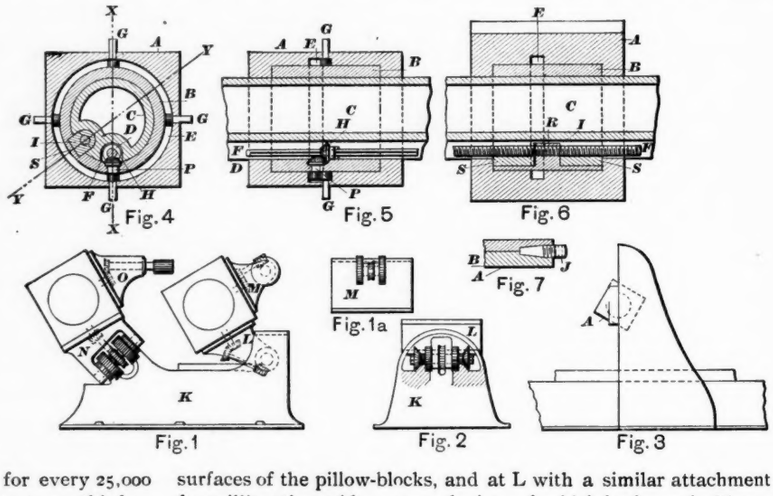
JOHN T. USHER.

Mr. James P. Hayes, Meriden, Conn, submits the devices shown in Figs. 1 to 7, as solutions of problems 1, 2 and 3.

Mr. Hayes calls his device a "turret-head milling machine," and gives the following description of it, with slight modifications:

"Fig. 1 shows a milling machine, similar in construction to a planer, but which has a cylindrical cross-rail, upon which the turret A is free to revolve.

"In Fig. 2 the turret is shown in two positions ready for operating, at N with one fixture or attachment for milling the bevelled



surfaces of the pillow-blocks, and at L with a similar attachment for milling the guides; an end view of which is shown in Fig. 3.

"Fig. 4 is an end section through the center of the cross-rail and turret.

"Fig. 5 is a longitudinal sectional (front) elevation though the line X X of Fig. 4.

"Fig. 6 is an inclined sectional (front) elevation through the line Y Y of Fig. 4.

"In the figures similar letters of reference denote the same parts. C is the cylindrical cross-rail, which has two slots running lengthwise of it; D is a splined shaft in one of the slots; H is a bevel gear, held in the ring B; P another bevel gear, held also in the ring B, and which has a pinion P' on the end of it; E is a groove in A, to allow the pinion P' to clear the turret when it is revolved. The pinion P' is only in gear with the pinion on the spindles G when either one is in position to be operated. I is a feed-screw engaging in the nut R, and is operated by a vertical shaft on the the end of the cross-rail. S S are two feathers fixed in the ring B and which slide in the slot F' to admit of the turret being fed across the cross-rail, but which prevents the ring B from turning on the cross-rail. J (Fig. 7) is a taper pin threaded on its larger end, used for locking the turret in any of its four positions. The mills of the attachments L and N (Fig. 2) are driven by means of a worm-gear and bevel gearing."

Mr. Hayes then proceeds: "If the turret was very much out of balance when the attachments were applied, a revolving device could be applied, and by having suitable stops upon the cross-rail, this rig could be handled very quickly, I think."

From a mechanical stand-point the above devices are complete in every detail. It would, however, require some modification of the details of construction before the devices could be practically applied to the purpose intended, comment on which is at present reserved.

Problems 1, 2 and 3 will be closed on the 20th day of the present month, and all further solutions or matter pertaining thereto must reach the editor of this paper by that time.

* * *

FOR VALUE RECEIVED.

W. H. WAKEMAN.

Some time ago I was present when some laborers were paid off, and as pay-day did not come regularly with the proprietor, some of them received quite large sums of money. As one of them was counting over his roll of bills some one asked him if it was for value received, to which he replied in the affirmative, although he scarcely understood what was said to him.

This question has presented itself to me many times since then in connection with working engineers and their pay, and I wish to present at least one case and allow the reader to judge for himself concerning the answer.

A young man took charge of a plant consisting of a pair of 60-horse power tubular boilers and a Corliss engine. I will not state the exact amount that he was to receive per week, but it was not large. The understanding was that there was to be no lost time, for sometimes the plant was operated but eight hours per day during the winter season. This was not an easy place, for the engineer must do his own firing, and coal was not always used for fuel. He was at his post about 5 a. m., took half an hour for breakfast, and had everything in good running order at 7 o'clock. After he had worked there a few months business began to be very brisk, and orders came in so fast that the factory was run until 9 o'clock in the evening. For this overtime the young man expected to be paid, but was informed that it was all a day for him, and that he would be paid for holidays and short days, and thus it would be "evened up." Now, during a portion of the year the plant could be operated with one boiler, but notwithstanding this it had been customary to clean and inspect boilers on a holiday, and as this is one of the worst jobs that an engineer has to do, the reader can judge of the amount of recreation obtained. In order to improve the time this engineer laid off one boiler, cleaned it and had it inspected, then used the clean one while the other one was treated in the same way. His object was to get this work done before his holiday came, so that he would get a day for himself to pay him for a portion of his overtime. But did the proprietor, when he found that the boilers were already cleaned and inspected, express satisfaction because the affair had been managed so nicely and tell the engineer to enjoy his much needed day of rest? Oh, no. He simply told him that as the boilers were cleaned, they would run until 1 o'clock on the coming holiday and that he might have the rest of the day to himself. After shutting down at that time, caring for his plant and getting his dinner, there was but little time for enjoyment or rest, and other holidays passed in the same way, although but a small portion of the hands would work on such days, and those who did stay performed as little work as possible. When this young man received his weekly stipend was it for value received?

The summer was succeeded by the fall and the winter, and for a few weeks the running time was reduced to eight hours per day. As there was no watchman to get up steam and heat the factory, the engineer must do it, and he was also informed that as the office was occupied until 6 o'clock, they expected him to stay and keep up steam for heating until that time. By this time our young engineer began to wonder where the rebate for all of his overtime was coming from, and he is still wondering about it, for it has not yet put in an appearance.

Now if this had been a place where a good salary was paid and a fireman furnished, I should not have considered the case worthy of notice, for when business is good the working engineer must do much hard and unpleasant work and make long days, but he should be paid for it, and he was not in this case.

The natural consequence of such treatment is that unless a young man has an independent disposition, takes much pride in his work, is very jealous of his reputation and has a strong character, he will become discouraged, his work will be neglected, the "boss" will be considered an oppressor and affairs will become demoralized in general.

I do not wish to be understood as approving of such a course on the part of any employee, under any circumstances, but only state the consequences as I find them. Such an ill-advised and short-sighted policy on the part of employers and superintendents is responsible for many strikes, lockouts, boycots and general dissatisfaction, and seldom or never does pay in dollars and cents. This is not sentiment, but business.

While condemning such mismanagement in unmeasured terms, I hasten to advise young engineers, and old ones, too, concerning the best course to pursue under such circumstances. I am firmly convinced that good service in the engine room is worthy of a good salary, while poor service is not worth anything. I believe that every man in charge of a steam plant should care for and run it to the very best of his ability, regardless of the salary that he receives. This may seem like a strong doctrine and will undoubtedly be condemned by some readers who are dissatisfied with their employers, their engine and boilers, their salary and with other things in general. To such I would suggest that they carefully consider the following reasons for conclusions that I have arrived at before they pass judgment on the case.

If a man is hewing wood or drawing water for a living, it may be good policy for him to hew or draw according to the pay that he receives, but when a man cares for a steam plant to the very best of his ability he has done nothing more than his duty to himself and to those whose lives his carelessness will endanger. Under no circumstances is he justified in nominally keeping his position and secretly neglecting his duties in an endeavor to "get even" with the boss. Men who take this course usually claim that when they get a better situation they will attend to their duties better. Well, such men occasionally do get better situations, but they seldom or never do any better in their new place than they did in their old one, for we are all so constituted that when we have once formed habits it is not always an easy matter to reform them, and the result of my observation is that if a man is contented to allow one plant to degenerate on his hands, he will do the same thing in another place. I simply state these things as I find them. On account of my convictions along this line I am sometimes accused of talking and writing in the interests of the capitalist alone, but to this I strongly object, as it is a mistaken idea.

If an engineer is in a place where he is not appreciated, it is advisable for him to so conduct himself that he will get a better situation as soon as possible, and every engineer is rated among his fellows according to his knowledge of steam machinery, and the way he cares for his plant, and not according to the salary he receives.

If a steam user wants to hire a good engineer, he looks for one that is doing good work in his present situation. If he goes into an engine or boiler room and finds the place dirty, the gauge cocks disabled, the joints leaking steam, the engine pounding badly, oil and waste scattered about the floor, and the oil cans battered up until they are unfit for use, he does not care to hire such a man to run his plant, for he knows that it is quite possible that said man will do no better in another place. He does not inquire what wages this man gets, then sit down and consider that if he had more pay he would run the plant better. He merely concludes that he does not want such a man in his well equipped plant, and so looks further for an engineer to place in charge of it.

If this man had been found in a neat and tidy engine room, where it was plain to even the casual observer that the plant was well cared for, and consequently he had been selected to take charge of the better plant at a larger salary, would it not be more satisfactory in every way, than to stay in the old place studying up how to do work according to his salary? I believe that it would have been so, and this is why I advocate the idea that a steam engineer should do his work to the very best of his ability, without regard to salary received.

As a rule, steam users who are satisfied to have their plants run in a slovenly and careless manner, do not pay large salaries, and when they find a man that is satisfied to do his work in this way, they feel that they will be able to keep him in their employ, for others who pay more and want their work done in a better manner, will not want him, for they fear that if they should give him a trial, when he received his salary it would not be "for value received."

* * *

That new kink will interest some one else; send it in.

PATTERN SHOP SUPPLIES.—(1.)

JOHN M. RICHARDSON.

As every pattern shop must have its quota of supplies they being as necessary to its existence as the contents of the pantry shelves are to housekeeping; it is my purpose to enumerate the most common ones which do not include either the machine tools belonging to the shop, or those expected to be furnished by the workman in his chest or kit, and give a few rambling notes concerning their use.

The journeyman who sees this will say there is nothing new here, and it may be well at the outset to say that I am making no claims for anything original, for I am not theorizing.

The announcement of your journal, as "a practical not a technical paper," always seems very pleasing to me, and gives me courage to branch out on common every day things, hoping that some spark may "strike the tinder" of some apprentice, as it were, and ignite a fact or two that he had not previously thought of, concerning things in the pattern shop.

I will head this somewhat disconnected list with

SANDPAPER.

This can be procured in two ways; either in the common ordinary sheet size 9x11 inches or in a long continuous roll about 30 inches wide. For ordinary use, the sheet size is the more convenient, but if sandpaper wheels are used the other is best, as it saves patching on separate pieces.

A very convenient way to keep the roll, is to make two wooden brackets and attach them to the wall, having a slot in each; then put a long wood dowel or piece of gas pipe through the roll and hang it in the slots. Just below this, fasten a strip of wood about 1½ inches wide and 1½ inches thick and a trifle longer than the width of the brackets, having a slot sawed in the middle, made by one cut of the circular saw about ¼ inch deep. To cut the paper, simply pull down the end of the roll until the right length has been reached and draw a putty knife quickly across the paper, pressing it into the slot. This method I have used with great success, it making a very good cut.

All sizes of sheet sandpaper, from 00 to 1½, are useful in pattern-making, but anything coarser seems superfluous, as a man, if he is any kind of a workman, can usually get his job smooth enough with tools for No. 1 paper. Quite fine paper should be used for finishing, and never use any at all coarse to rub down a pattern after the varnish has been applied.

SHELLAC.

Orange shellac is the kind used in pattern-making, and some prefer to buy it ready mixed, while others mix it themselves. There is very little choice between the two ways, but it is somewhat less trouble to have a large jug of the ready mixed on hand when it can be procured of a reliable quality.

Orange shellac in the flake form should also be kept on hand to be melted into sticks as occasion requires. This stick form is almost indispensable for places where putty and beeswax will not stay to advantage, and is used by holding the stick over a flame and dropping it over the place needing it.

ALCOHOL.

This should be of good quality for nice shellac, and I would advise one to steer clear of wood alcohol in the pattern shop. Its smell even, is enough to set a pattern maker against it, to say nothing of its not making so nice a varnish and not drying so quickly.

LAMPBLACK.

The best quality is also important here, and as it is so cheap one can always afford a first-class article. It should be a dense black, extremely fine, soft and velvety to the touch, and not in the least coarse or gritty.

GLUE.

When we mention this article we attack the very vitals of pattern making, for a poor grade of glue is a never ending source of vexation and disgust. Some prefer to get it in the form of large flakes or broken sheets, others in a ground or pulverized condition, and still others adhere to cold liquid glue. As for me personally, I prefer to use hot glue of a good quality every time. Always soak glue thoroughly in *cold* water before setting on the heater. This brings it to a jelly, so that the heat quickly transforms it into the liquid state.

A test of good glue is to put a little between the ball of the thumb and middle finger and keep pressing them together and then drawing them apart, and if the glue is tenacious, one can soon separate the fingers a distance of several inches and the glue will follow them in long delicate threads.

BEESWAX.

Only use that which is warranted pure. It comes in bars or cakes weighing one pound each. This is one of the most useful articles to patch bad joints, nail holes, etc., and stands midway in rank between putty on one hand and hard shellac on the other.

PUTTY.

This well-known article is a mixture of whiting and linseed oil, and can be mixed by the pattern-maker or bought ready prepared, as one chooses. I prefer the latter.

There is a happy medium to be obtained in the consistency of this material, for if too soft it sticks to the hands, and when too hard it refuses to stick to the work. Some workmen mix lampblack with it when it is used on black shellaced patterns. When mixed with a certain amount of plaster of Paris it dries very hard and thus becomes more durable. It can be kept soft for a long time if submerged in a jar of water, as the air is thus excluded; but putty should never remain exposed to the air, and if not kept in water it should at least be put in a can with a tightly fitting cover.

LEATHER FILLETS.

Leather is now coming to the front for this purpose and can hardly be excelled, It can be purchased in long strips six inches wide and less, termed "bellies," for so much per pound, this being a poorer grade of leather but answering nicely for this purpose. When in this form the workman has to cut his own fillets, and there is more or less waste, and when this is considered together with the man's time it is about as cheap or cheaper to buy them ready made. There are several firms now which make this branch a specialty, and are turning out very handsome fillets of an even width with sharp edges, and of all sizes from $\frac{1}{16}$ to ¾ inch.

NAILS.

Bung head wire nails are now used almost exclusively on pattern work, and a full supply should be kept of sizes ranging from at least ⅜ inch to 3 inches. The sizes of wire vary greatly in nearly every length, and for common use I would recommend the following numbers as not so large as to be liable to split the work and yet strong enough for ordinary use: ⅜ inch, 21; ½ inch, 20; ⅝ inch, 20; ¾ inch, 19; ⅞ inch, 19; 1 inch, 18; 1¼ inches, 17; 1½ inches, 16; 1¾ inches, 16; 2 inches, 15; 2¼ inches, 14; 2½ inches, 12; 2¾ inches, 12; 3 inches, 11.

SCREWS.

It is better to keep a pretty full stock of these on hand, but as there are so many different sizes each shop must be governed somewhat by its needs and regulate their supply accordingly. A case of drawers properly labeled is the best way to keep them, and for pattern making the smaller sizes of wire are preferable; the numbers 10, 12 and 14 being used for lengths between 1½ and 3 inches. Very large screws should, of course, have the wire proportional to their length.

HAND SCREWS.

This very important item should be well provided for, and not less than a dozen of each size should be kept. Some as small as 4 inches are very nice for fine, light bench work, but probably 10 and 12 inch ones are used more than any others for segment work and gluing up stock. Larger sizes are useful for heavy work, and about half a dozen cabinet makers' clamps 4 feet in length, will find quite a field of usefulness in most every pattern room for holding wide boards, etc., after being glued.

POWDERED OXALIC ACID.

This, to many, undoubtedly seems like a queer item for our list; but what pattern-maker has not noticed with regret and disgust the condition of his orange shellac after standing for some time in the pot, especially if there is a metal binding about the brush. Now this dirty brown discoloration can be remedied almost as if by magic, by adding a pinch or two of powdered oxalic acid occasionally. The acid should be put in and the shellac stirred, then after a time the clear yellow of the varnish is restored to its former brilliancy.

* * *

Mr. LEWIS M. POMEROY, late of Coolbaugh & Pomeroy, has been appointed special agent for the railway department of the Cambria Iron Co. and the Latrobe Steel Co. with an office at 33 Wall street, New York City.

OBSERVATIONS IN AN OLD SHOP.—:.

One of the most interesting shops it has ever been my pleasure to visit is that of the Silver & Gay Co., North Chelmsford, Mass. Established in 1832, it was a pioneer in several ways, and for many years did a large share of the work for the surrounding country. The gentleman who kindly showed me around the shop was Mr. D. Gay, son of the original member of the firm by that name.

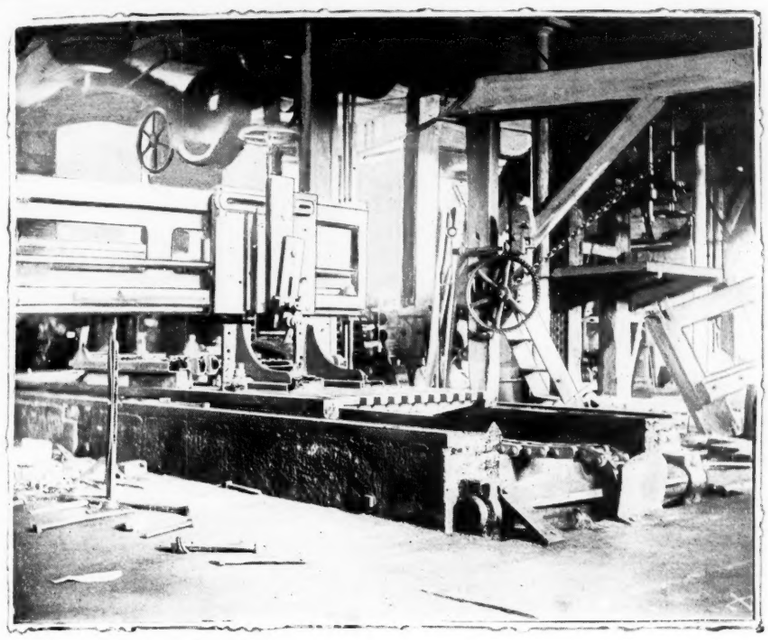


FIG. 1.—PROBABLY THE OLDEST PLANER IN AMERICA.

It was here that Mr. Frederick W. Howe, whose name is well known in mechanical circles, learned his trade, finishing in about 1854; and on the day of my visit I met a man who worked with him in the shop there.

Mr. Gay showed me some of the old records of tools sold, which proves the date of manufacture of many of the machines in use in the shop to be even earlier, as there were few instances where the tools were not first built for their own use. Among these records are the names of nearly every railroad in this country at that date, of most of the large mills in New England, and of one concern, the Augusta Machine Co., as far south as Augusta, Ga., who bought a 16-foot planer in 1850, which was captured during the war, was sold and afterwards repaired by the builders.

In 1836 they built their first planer, which is illustrated in Fig. 1, although it is impossible to give as good a view as might be desired, owing to the new cross-rail having been built in front of the original one, to give a wider range of work on the end of bed. The original is still in existence, however, and has a capacity of 3½×3½ feet. The bed is of granite, set on a solid foundation, and dressed smoothly to receive the cast iron ways, which had to be chipped and filed, as there was no other planer in existence in that part of the country (or any other part so far as known). The ways of the table were also chipped and filed, it being made with a V on the left hand for a guide, and a flat way on the right side. The driving is by a heavy flat link chain, shown fairly well in the cut and more clearly in the detail, Fig. 2, consisting of flat links joined as shown with bushings or thimbles to maintain the proper distance apart. The "sprocket" wheel shown is merely an idler, the driver being at the other end, driven by gearing, belted from an overhead shaft. It has automatic reverse, which can be controlled by hand from any position on that side of the planer, and has an automatic trip for lifting the tool out of the cut on the back stroke, a refinement which has been abandoned by later planer builders as unnecessary. It was in use when photographed, and does all of the heaviest work of the place, which is mostly frames for textile machinery. The jib crane, with a worm gear for the lift, is in evidence here as it is all over the shop, showing a greater appreciation of the cost of handling materials than many shops of much later date.

Adjoining this are several grinding lathes, like Fig. 3, on which considerable work was done in years past. The stone is probably four feet in diameter and the bed eighteen feet long, it being known as a spindle lathe in some localities, as spindles for spinning frames were ground on it. This was also used for grinding line shafting before the advent of the cold-rolled, and there are probably many shafts running in mills in that section which were ground on it. It was preferred to the turned shaft both on account of cost and finish, but had to give way to the cold rolling process.

Across the room, in a corner of the basement, is another tool with a granite bed, the lathe shown in Fig. 4, which is quite a curiosity in many ways. Having about forty-eight inches swing, it is quite powerfully geared to the face-plate, as in modern lathes, and has a large swing over the carriage owing to the curved shape at its center. This has power cross-feed if desired, by simply dropping the long rod with the worm on the end, into the large worm-wheel on front of carriage. The carriage is fed along the bed by a chain on inside as was common in many of the older lathes. The tail-stock has screws for side adjustment as seen in the illustration. The tool-block has a long slot at right angles to the other, for holding a tool-post in any desired position. This style of tool-block was quite common, and Fig. 5 gives a top view of one often used, which lacks the short extension shown in Fig. 4. The face-plate was used as a chuck, as seen by the jaws, which were adjusted by screws

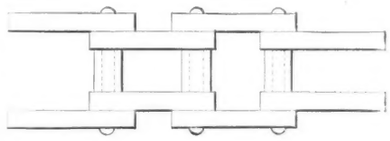


FIG. 2.

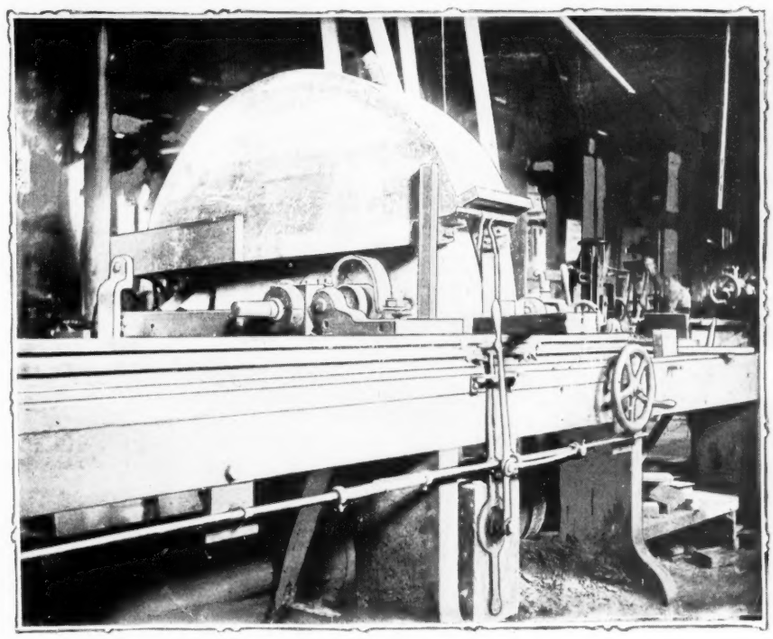


FIG. 3.—GRINDING LATHE.

not shown in the blocks holding the jaws. This is of about the same date as the planer.

An old lathe, evidently built before the tools just shown, was rather a curiosity in its way, and as a satisfactory photograph could not be obtained, the writer sketched the method of securing feed for the carriage. The lathe spindle carries a pulley on the

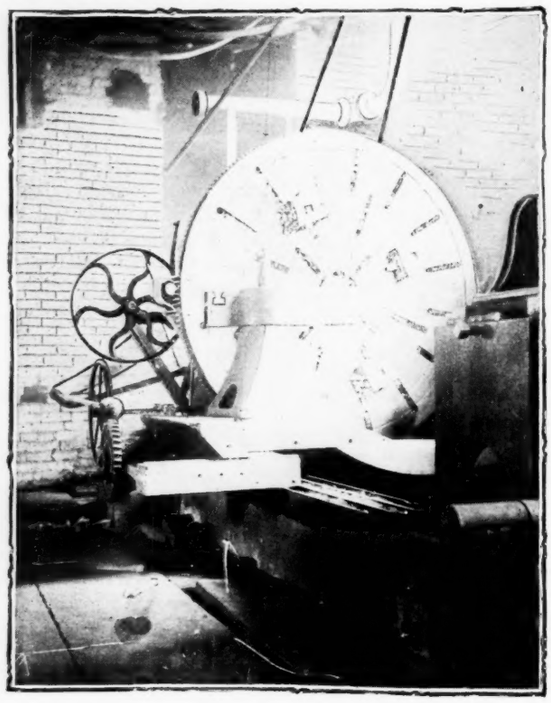


FIG. 4.—OLD LATHE WITH GRANITE BED.

back end, which drives the pulley and shaft beneath, fastened to the lower part of lathe legs. This shaft carries a worm driving a worm-wheel A, which in turn drives pulley B by a belt. Fastened to B is a sprocket-wheel C, which drives the chain for feeding carriage. This was before the screw-driven lathe carriages came into use, and is interesting as a relic, showing that ingenuity is not confined to the present day. And yet we find men to-day endeavoring to introduce methods as far behind modern practice as this is behind the screw, simply because of a fancied defect or a desire to have something new. In the adjoining room is what to me seemed a wonderful machine considering the time it was built, about 1840. It is the 16-foot boring mill shown in Fig. 7, and isn't as out-of-date as might be expected. It is a substantially built machine, has three heads, all having power feed in both directions, and is conveniently handled by the operator. The center head is arranged to work as a slotter, and after the pulley has been turned on the rim (two tool heads at work, one on each side) and the hub bored by the center head, the slotter combination was put to work and the key-way cut, completing the pulley before leaving the machine. Having a capacity of 16 feet, it is evidence of the good equipment of this shop at an early date. The table is supported by rollers under the edge, is driven by pinion at outer edge of table, and having the cones shown behind it, has quite a range of speeds and feeds.

Another jib crane is seen, this time driven by a pinion instead of a worm, and the chain at extreme right of picture shows that still another crane is close at hand. More of these interesting tools will be shown in a later issue.

* * *

THE Gisholt Machine Co., of Madison, Wis., have inaugurated the profit sharing system in their works, the first distribution taking place on December 21st. All who had been with the company a calendar year received 5 per cent. of their wages, over forty men receiving sums varying from $10.00 to $40.00. It has long been the wish of Mr. John A. Johnson (president of the company) to make the permanent employees participants in the profits which their labor, both mental and manual, has helped to create. The dividends were paid in cash, with the suggestion that the money be left with the company as a saving fund, onwhich 5 per cent. interest will be paid, and which can be withdrawn at any time. This was merely a suggestion and not in any sense a condition. It speaks well for the management of this company that they are warranted in doing this, and it shows a commendable desire to treat employees generously, which we believe will of itself be a paying investment.

* * *

NOTES FROM NOTOWN.—8.

ICHABOD PODUNK

Since writing about the experience of my friend Walter Leeds and the economy (?) of employing cheap men to design tools, a friend of mine who is manager of a large tool building works tells me that the mistakes of their drafting room cost as much as the salaries of the men, and they employ a fair grade of men, too.

If this is true in their case, what must the percentage be where only cheap men are employed? This shows that a man to be a first class draftsman should also have a shop training, as he can then tell whether a device which appears all right on paper will work in practice, and whether a design which appears to be good can be made more cheaply in some other form. We have all seen pieces designed and cast which could not be swung in any lathe in the shop, when, by simply changing the design, the work could have been done for half the money.

Drafting-room economy does not consist in saving an hour's time when it cost the shop ten dollars every time a casting is turned up, and it often happens that an hour's time on the drawing or design will save dollars in the shop.

I went into the Combination Tool Co.'s shop the other day and found Mr. Combine, the manager, in rather a despondent mood. "Can't sell anything to speak of, although I advertise heavily in the best papers. I can't understand it. Our tools are of good design, well made, and not especially high in price. Now take this shaper, and it's as solid and well made as any tool on the market. By loosening these bolts

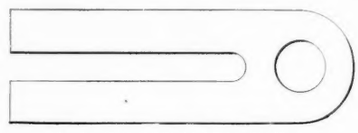


FIG. 5.—TOP VIEW OF TOOL BLOCK.

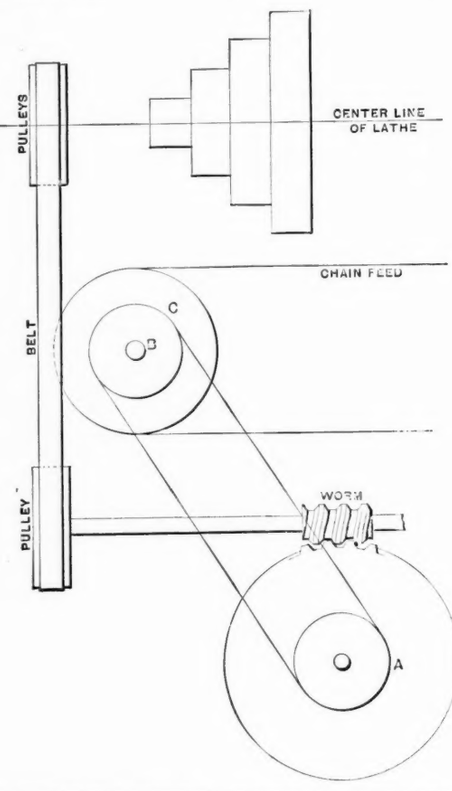


FIG. 6.—CHAIN-FEED MECHANISM.—OBSERVATIONS IN AN OLD SHOP.

and connecting this driving-rod to the slotter head, we have a good slotting machine for light work."

"Do you make any 'straight' machines," I asked; "that is, either shaper or slotter, without the combination?" "No, its cheaper to combine them than to make separate machines, and

it's so handy to have the machines together sometimes." "Have you ever been in the new engine shop, Mr. Combine, where you sold one of your machines some time ago; that is, do they know you there? No! Then come with me, but don't say anything, and we'll see what their opinion of the machine is, without knowing who is listening." So we went to the shop mentioned, and as I knew the foreman I asked him what he thought of the combination machine. "Well," he said, "it we only had one job on hand

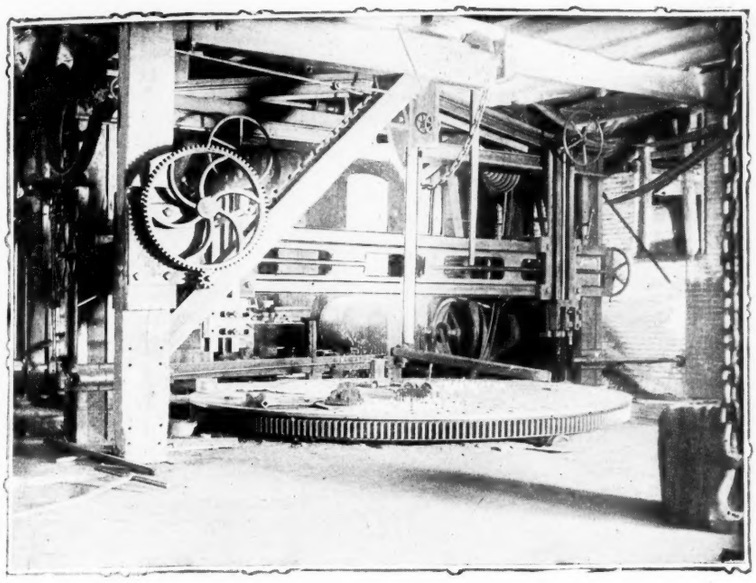


FIG. 7.—OLD 16-FOOT BORING MILL.—OBSERVATIONS IN AN OLD SHOP.

at a time and only one piece which required slotting and planing, that machine would be all right. It's a good machine, well made, works well, and if we only had enough of them" (here Mr. Combine's face brightened), "so we could keep going whether we ever used both parts or not, it would be all right. Here comes a man now who wants to use the slotter, but this shaping job won't be done for an hour; now I've got to find work for this man till the other job is done, and then the man who is using the shaper will be without a machine to run. These are all right for one man shops, but we are sure to be using one end when we want the other end the worst; and that's where the machine loses money for the firm, for if we hadn't bought that we would have had two separate machines." I couldn't help asking him if he would buy these machines if he was managing the plant, and he replied, "Not by a jugful, Mr. Podunk, and it's saying nothing against the tools, either; but they are not adapted for a large shop. It doesn't pay to have any machine or part of a machine lying idle, and here one part or the other must be doing nothing all the time." Mr. Combine had kept silent as long as he could, and broke out with: "But you have the other part handy when you do want it, don't you?" "Yes," was the answer, "and we pay a high price for doing it. That machine cost 50 per cent. more than a 'straight' shaper would, and that is paying rather high for the possibility of using the attachment some time within the next ten years. As I said before, the combination machine is all right for a small job shop, but for any regular work they will never be in demand, and the quicker the makers chop these machines in two and have each separate, the sooner they'll commence to sell more goods." Then we left, and I wondered if Combine had seen why his tools didn't sell, but just before I left him he said he was going to fix that machine so both shaper and slotter could be used together; so I guess the lesson wasn't very effective; and after he has made the change will probably wonder why the sales don't commence to increase.

Nor is this defect in machine design confined to building two entirely separate machines together. When you commence to add attachments and special features to a lathe, you are tending to make it a universal machine, and as everything points toward specialties, it is well to consider the tool equipment from this standpoint. Our Mr. B. is sort of a crank on this subject, and perhaps I've absorbed some of his ideas from hearing them expressed quite frequently. Anyhow, I have a few ideas on this subject which would at least have a trial if I was buying machinery for a new plant. As this letter is long enough already, I'll tell later what I would do if I were boss.

* * *

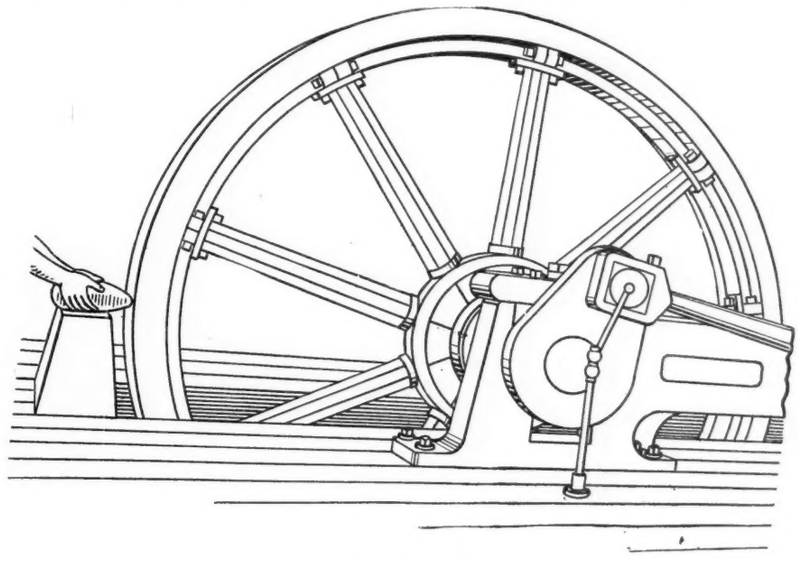
MR. CARL CHRISTIANSEN, superintendent of the Mossberg Mfg. Co., Attleboro, Mass., has a very convenient way of identifying their castings, so that the latter can be easily and quickly sorted out by a laborer without requiring the time and attention of some one whose services are more valuable.

Each machine is designated by a number, say 28, and all the castings for that machine have this number thereon and also a serial number. For instance, the first casting would be 28–1, the second 28–2, and so on. The corresponding numbers are affixed to racks in which the castings are kept, so that they are always obtainable without trouble. The expense of this is comparatively small, being limited to the cost of the letters which are tacked on to the patterns.

* * *

TRUING OFF FLY-WHEELS.

There is often a slight lack of truth in fly-wheels, caused either by their being turned off bodily or being keyed on their shafts improperly or by local changes taking place, from their being turned down before they have got their "set," in which case they may spring a trifle out of line, after being turned; and then sometimes the finish is not all that could be desired. While "fudging" should be discountenanced except where it is practically absolutely necessary, it is well to be able to know how to "fudge" if there is no other way out of it. One instance of "fudging" is truing off a fly-wheel after it is in place, and may be accomplished by using a piece of grindstone with a heavy



TRUING OFF FLY-WHEELS.

block as a steady rest. This, of course, will not remove much metal, but it is practical where there is but a trifle to take off, especially where it is only desired to remove the tool-marks from the rim, in which case it answers admirably.

* * *

MR. LESTER G. FRENCH was unable to supply his article this month, but we expect the next paper in the March issue.

PRACTICAL NOTES ON STEEL.

S. W. Goodyear.

Let us assume for the sake of getting started that steel in general, if it gets used for the purposes to which it is best adapted, and is properly treated will, as a rule, behave well, and does not deserve the abuse it so often gets as being the most perverse, refractory and unmanageable of all materials with which mechanics have to contend. First in line comes the question. "How shall we determine to what particular use any particular steel is best adapted?" and just here it occurs to the writer to quote from an old friend long since departed from this life, but whose name will always be connected with inventions of such wide spread utility as to have become household words. Said this old friend, "Don't you know that it is just as important to know what will not work, as it is to know what will work?" The application? Well, my answer is, don't try to select the right steel for any particular use by its looks; don't assume that fine grained steel, with beautiful fracture, the fracture showing great strength, looking as though "nibbled off by mice" (of course you have all heard this) must necessarily be good, while all coarse grained steel, which breaks with a uniform brittle fracture, no marks of the "mice's teeth," must be of inferior quality or practically worthless. *This test won't work*, and it is well to know it. That there will be a difference in fracture as between steel of high temper and that of lower temper is true, but the main cause of difference in fracture, that difference by which so many select one piece as good and reject another as worthless, is to be found in the heat at which the bar or forging was worked and at what heat the work ceased. The grain in the steel often indicates simply condition; not quality, not temper, and to any reader who persists in selecting or rejecting steel just as the fracture shows fine or coarse grain, let me say that here is ground for interesting experiment. The coarse piece by simply heating to fair forging heat and being hammered, worked down to low red heat, will then show the beautiful fine grain so much admired, while all that is needed to destroy the fine grain in a piece which has been selected as perfect, is to simply heat it to the same high forging heat and then to either let it cool down without working or to do the work at high heat, and to let the working cease while the heat is still comparatively high.

Of two bars of steel, one selected as of superior quality because of firmness of grain, and the other rejected as worthless on account of coarse grain, it may be that both were made from the same ingot, and are identical in quality and temper, and if put into use their ultimate value would be alike; or to carry the comparison further, the coarse bar might, on account of peculiar adaptability of quality and temper to some particular use, be pronounced the best ever seen, while the fine one, on trial, might be branded as worthless from not being of suitable quality or temper. But should this state of things exist at any time, don't let either fineness or coarseness of grain be looked upon as the cause, or even as a very important factor tending to success or failure. How, then, shall we know? Well, if it were practicable we might test each bar by forging, hardening, etc, but that will not answer; it is too much trouble, involves too much expense, and in the case of forgings it would not do at all, and forgings by the thousands are being furnished by steel manufacturers on which much is expended in labor before the crucial test, hardening, determines whether success or failure are to crown the efforts. This all points in the direction of assuming that the proper way to select steel for any particular use is to take the manufacturer into your confidence and telling him what the steel is to be used for. You will then draw upon his vast store of information which has come to him through not simply his own experience, but the experience of thousands of customers. Good, thoroughly reliable steel, must be made from good iron, by approved methods. Does not this imply that, since it is impossible to determine whether it is good or bad, by examination, looks, touch, smell, etc., as in the case of selection of other supplies the consumer must depend upon the ability and integrity of the steel manufacturer to get good steel? Here, then, comes in the necessity, or wisdom at least, of confining our purchases in steel to well known brands, and just here is one of the most knotty of all the puzzling situations which confronts the investigator who starts out to learn what is the best steel to use for any particular purpose, for as he commences to make inquiries he will find that not only all of the good steels, but many of inferior quality, have their friends and advocates, each of whom is sure if only his favorite brand is secured, it will prove to be just the thing. How are we to account for the differences of opinion in relation to value of some steels? How can it be possible that when Smith uses exclusively ——'s steel, one of the most popular of English brands, saying, "Never gives me any trouble, would not take the best American steel as a gift." Jones, his neighbor, in identically the same line of business, uses no imported steel whatever; won't have it in his shop, believes that just as good steel can be made at home, and is demonstrating daily by a service fully equal to that in Smith's shop, the entire soundness of his position? To answer this question intelligently would involve too much detail in investigation and experiment, in many cases, for the reader to be willing to spend time to follow, but, as the foremost reasons for these conflicting opinions, we may safely assume that the first indelible impressions, as to the value or worthlessness of any particular brand, are the result of the merest accident. To explain: Sometime in the experience of our friend Smith he was induced to try American steel, and accidentally, either this particular steel was unsuited, in quality or temper to his use, or his treatment was unsuited to the steel, the result was a disastrous failure and he decided to "never get caught again." Per contra: Jones had, in his earlier experience, been just as constant a user of ——'s steel as Smith now is. Not at first on account of any partiality for imported steel, but because there was practically no other, and later, when American steel had been brought to such a state of excellence as to demand recognition, Jones, being naturally inclined to favor home products, tried it, and accidentally hit upon the right steel, which he just as accidentally treated just right to put it at it's best, which resulted in his adoption of that particular brand of steel. Is it not easy to see that by a slight accidental change in the conditions the exact opposite might have resulted in both cases?

"But," says some impatient reader, "what are we getting out of this? Give us something in the way of practical instruction in the art of working and hardening and tempering." That is what I am coming to if you have patience, but I am aware that no matter what rigid rules may be advised there will be many steel workers both among the smiths and machinists, die and toolmakers, hardeners and temperers, and all along the line of steel using who will denounce as unnecessary, foolish, injurious, even much which I believe to be of vast importance.

Stating in my way what seems to me to obstruct the getting to the bottom of this endless discussion as to what steel shall be used and how it shall be treated, let me say that the trouble comes from too many opinions which are opposed to the facts that there is always in the case of every peculiarity, good or bad, in quality, condition and behavior of steel, a good substantial reason, a cause, a good healthy fact, if only we can discover it, but if we permit ourselves to be controlled by preconceived notions which are false, the facts, although governing, are to us a dead letter, and our reasons for success or failure, as we put it, are in point of fact groundless.

In the smith department, and for that matter often reaching all through the cold working department, there is a strongly fixed belief that hot working, forging, adds wonderfully to the value of steel, and following up this too generally accepted belief, there are shops in which through injudicious treatment by the smith, really good steels are made comparatively worthless, or are robbed at least of a large percentage of what would be under proper treatment their true value. Is not working then necessarily injurious? Does annealing of necessity injure steel? Not by any means if properly done, *not overdone*, but to go on mauling and abusing steel after it has been worked enough, to heat steel hotter after it has been heated sufficiently, and to keep it soaking for hours at a heat as high, or higher even, than is necessary, for

annealing is without question injurious. "Then you don't believe that the more steel is worked, hammered, etc., the better it is?" is the exact question which has been put to the writer many times, and as often answered in the negative. Enough working to put it in proper condition in the process of manufacture is as important as the selection of material and adherence to formulas in mixing and melting, and who should know better how or be better equipped to do this proper amount of work, at proper heat, than the steel manufacturer?

The work of the smith should be considered on the lines of convenience, economy, necessity, if you please, and should be done with great care to preserve the good qualities of the steel operated upon. Let's look into this matter of alleged benefit derived from re-working, forging, etc. In the manufacture of merchantable sizes of bar steel, or of forgings, such as die-blocks, etc., at a steel works there has been, let us assume, a sufficient amount of work, forging, for that is just what it is, in getting the ingot to billet form, and from that to bars or forgings, and it is reasonable to suppose that the steel manufacturer is better provided with suitable appliances for heating and working to sizes and shapes required than the average smith, which furnishes ground for the assumption, boldly stated by some and flatly contradicted by others, "that steel in the bar, as it leaves the hands of the steel manufacturer, is in its best condition." Is it? It should be, so far as forging is concerned, and if it reaches the steel users hands annealed, for certainly the steel manufacturer should be well informed and well equipped for annealing, there is no reason why the smith should think that his work, in forging, should be called for to improve that which is really at its best. But there are many cases in which it is not practicable or economical to use steel in such size or shape as it can be had in from the manufacturer, it must needs be forged, and oftentimes welded, and at least, if nothing else be done to it while hot, it must be heated for cutting from the bar to such lengths as required. Here then begins the perilous road through which steel must reach its finished state in the thousands of implements which depend so largely for their ultimate value upon the treatment at every stage being what it should be.

What is proper treatment in forging? Depends upon what the forging is, upon how much there is to be done upon the piece. If there is much to be done the steel should be heated to a good mellow even heat, thus insuring its being worked to required shape and size without danger of straining and rupture, as would be the case at too low heat, and as the work continues down to lower heat, or the finishing heat being low, the same refining influence will be brought in play which had put the steel into proper condition in the bar, while if but little work is to be done it is best to let the heat be correspondingly lower, and thus preserve, as far as may be, the refined condition which the judicious working of the steel manufacturer had produced. There is one thing not to be done. Don't heat steel to a high working heat and then not work it. Who does? Well, a great many do. Cutting pieces of steel from the bar, hot, as often done, is a most pernicious practice. To have the chisel sink into the heated steel readily, it is heated too hot, and often heated unevenly, that is, when a piece is to be cut from the bar for a die or similar use, the part which is to be cut with a chisel is heated quite hot, while, perhaps, the other end of the same piece when cut from the bar is not even red hot. Now is it not plain that on annealing such pieces there will be uneven condition of grain which will have much to do with danger of cracking in hardening, and with ultimate value of the die when put in use?

Much is said about lack of uniformity in steel, but it is safe to say that when steel is furnished by a reputable house as uniform in quality and temper (and uniformity in temper, *i. e.*, percentage of carbon is really a most important thing to be considered), there are a hundred cases in which lack of uniformly proper treatment in forging, annealing, hardening, etc., cause trouble where there is one of the lack of uniformity in steel.

But it is time to draw this long letter to a close by putting in a few "Dont's,"

Don't give steel long continued soaking heats for either annealing or hardening. In annealing don't continue the heat on a rising scale above the necessary degree, nor even hold it soaking at that heat, which may be just right, but as it heats gradually to exactly the right heat, and is evenly heated through, let it begin to cool down slowly from that point.

Don't give pieces which are to be hardened a long soaking heat in open fire. Why? Because there will be less safety from cracking, less tenacity, and there will be a partial decarbonization of the surface, which in hundreds of cases daily, is leading to the condemnation of steel as worthless and of hardener as incompetent; when the facts are that the steel *really did harden, as hard as glass, all but the surface, and that would have hardened equally well only for the soaking heat.*

Of course we have all known cases in which at the first heat the hardening has appeared to be insufficient, could file it; a second heat taken, a little higher, of course with not any better results, and then if the hardener was just a little profane he would say, "—— the stuff, I will heat it hot enough this time," and it would crack all in pieces. I have such a piece before me now.

* * *

ALUMINUM ALLOY TO REPLACE BRASS.

The Pittsburgh Reduction Co., says the *Aluminnm World*, are now ready to furnish alloys of aluminum to replace brass for casting purposes, which will have a specific gravity of between 3.0 and 3.15, where brass has a specific gravity of from 8.21 to 8.44; the brasses being 2.57 to 2.70 times heavier than the aluminum alloys.

These alloys contain a larger proportion of aluminum than the brasses do of copper; and when the selling price of the brass ingot is multiplied by its factor of relative weight, the aluminum alloy is now being sold at as low, and in some cases at a lower price, bulk for bulk.

This means a great deal, not only in the utilization of aluminum in the arts, but in the application of metals to a vast number of the engineers' constructions, and warrants the careful study of the relative merits of the two sets of alloys.

The aluminum special casting alloys which now sell in ton lots of ingots at from 20 to 27 cents per pound, according to quality, are relatively cheaper for the manufacture of castings than the brass now in general use for this purpose.

In a general way, their composition is from 70 to 75 per cent. of pure aluminum, together with zinc, copper, nickel, manganese, iron, and in some cases with titanium, chromium, or tungsten.

These alloys have as little shrinkage as ordinary brass, and can be re-melted in plumbago crucibles and cast with the same facility as can brass, and are now becoming largely used in the leading brass foundries of the country.

The bronzes, under which name are included the principal alloys of copper and tin, together with a few special compositions such as phosphor-bronze, aluminum bronze, manganese bronze, etc., are all higher in cost of manufacture than the brasses, and are now more expensive than the cheap special casting alloys of aluminum, and are at least equal in expense with the nickel and copper hardened alloys which contain 90 per cent. and more of aluminum.

The cheapest of the bronzes, containing from 1 to even as high as 10 per cent. of zinc, and with small percentages of lead and iron, cost at least 12 cents per pound and range as high as 15 cents per pound in ingots.

These alloys have a tensile strength of from 46,000 pounds to 50,000 pounds per square inch, in hard-rolled sheets. In castings, brass has a tensile strength of from 18,000 to 30,000 pounds per square inch, with an elastic ratio of from 25 to 35 per cent.

The hardened aluminum alloys compare favorably in tensile compression and transverse strength with brass alloys.

The special hard casting alloys containing over 70 per cent. of aluminum and having a specific gravity of 3.15 are furnished by the Pittsburgh Reduction Co., with a guaranteed tensile strength of from 25,000 to 30,000 pounds per square inch, and with an elastic ratio of over 40 per cent.

We understand that these alloys are made by directly reducing the metals in their electrolytic reducing pots, and special precautions are taken not only in this way, but in their general manipulations, so as not to oxydize or "burn" the metals having low metal points, and to prevent occlusion of gases, in making their alloys.

* * *

One of the best examples of ancient and modern history in bridge building was recently seen on the Naugatuck Division of the N. Y., N. H. and H. R. R. The bridge consisted of two spans, one of them being a graceful structure of iron or steel, which so often pleases the eye in small towns. The other was an old covered wooden bridge, not red as usual, but white, which made the contrast between the black of the iron span all the more noticeable.

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Entered at the Post Office in New York City as Second-class Mail Matter.

MACHINERY,

A practical journal for Machinists and Engineers, and for all who are interested in Machinery.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

411 AND 413 PEARL STREET, NEW YORK CITY.

ONE DOLLAR A YEAR, - - - - - - TEN CENTS A COPY.

FOREIGN SUBSCRIPTIONS ONE DOLLAR AND A HALF A YEAR; POSTAGE PREPAID.
CHAS. CHURCHILL & CO., LTD., LONDON, AGENTS FOR GREAT BRITAIN.

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THE TRADE IS SUPPLIED BY THE AMERICAN NEWS COMPANY OR ITS BRANCHES.

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THIS PAPER HAS THE LARGEST CIRCULATION OF ANY PUBLICATION IN THE MACHINERY TRADE

FEBRUARY, 1896.

THERE have been so many changes in the ownership of trade papers during the last three months that it is not strange to find rumors of this character connected with MACHINERY. For the benefit of our friends and others who may be interested we therefore state that this paper is not for sale and never has been, and that no change in ownership, management or policy is probable, except that we intend to push the circulation twice as hard in 1896 as we did in 1895. The income of MACHINERY is increasing at the rate of about one thousand dollars a month, and as the present owners have ample means to carry on the paper, its sale even at a high figure has no attraction for them.

* * *

DIFFERENT BRANDS OF DISCIPLINE.

One of the serious questions which confront a thoughtful and conscientious shop manager is that of maintaining discipline without being unnecessarily severe, for by making the shop a prison, as too many are, the men take little real interest in their work, and this means that the highest efficiency is not being obtained. In order to secure the most economical results from a machine, we recognize that it must have every advantage, must be carefully lubricated and be well cared for, and the same principle applies to the man who runs it. In the men's case the lubrication consists in making the surroundings as pleasant as possible, being as agreeable as nature and circumstances will permit, and above all treating men as men and not machines. The output of any such plant will be greater than that of the prison type of shop, with equal ability of managers in both cases. The advisability of profit sharing, of pensions, or other schemes, however generous and commendable, does not enter the question under consideration.

The iron-clad rules so often found invariably work injustice in some cases, and can in many instances be dispensed with, leaving each case to be settled on its merits and obviating the alternative of acting unfairly or violating your own rules in favor of some of the men.

The system of fines for poor work, for tools broken, and similar offenses, is liable to abuse, and it is a question whether it is entirely satisfactory in any case, although it is a common saying that the quickest way to reach a man is through his pocket. Still, there is the tendency to throw the blame elsewhere to avoid paying the fine in case of an unjust decision against him, or in fact in any case; and it makes a man feel anything but pleasant to have his wages cut into when he has counted on a certain sum each week. The result is likely to be a collusion between men and inspectors, with the effect of turning out poor work.

The plan adopted by Mr. G. R. Brown, general superintendent of the Fall Brook R. R., and first published in *Locomotive Engineering*, seems to have much to commend it, and as it has worked well on this road for several years, it cannot be called a mere theory or an experiment. Railroads are particularly prone to fines in the shape of suspension from work, and as this has been particularly successful in that branch of their service, it is worth noting. Mr. Brown's method consists in having a bulletin board on which all offenses are posted, without the names of offenders, together with suggestions that will tend to prevent a repetition of the accident. This has had a marked effect on the men and has secured a careful attention to details and improved service. There may be men who are not susceptible to such treatment, but this is simply an argument against the men, not the system; and it would be manifestly unfair to make rules based on these exceptions for the government of all. The survival of the fittest, if it means anything, means that these men must be crowded out to make room for their betters. It is best to investigate thoroughly before adopting harsh methods.

* * *

WHEN it costs more to remove bolts and screws from condemned machines than to buy new ones, it is time to economize by throwing them away.

PRACTICAL TALKS ON MECHANICAL DRAWING.— 3).

LOUIS ROUILLION.

SHEET VII.

DEVELOPMENT OF A 2½ INCH CUBE.

By the development of the surface of an object is meant the laying out of the pattern which, when properly folded, will exactly represent the surface of the object. A simple and easily conceived development is that of a cube. It is necessary to know

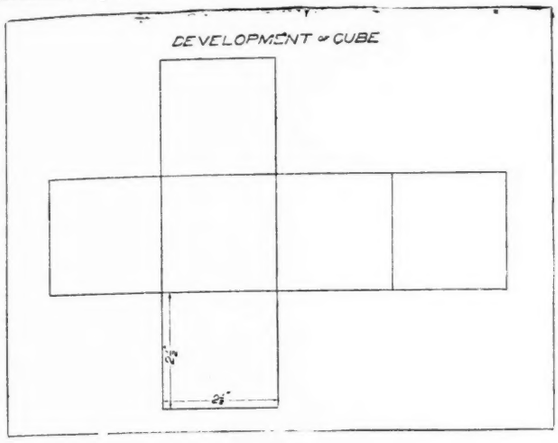


FIGURE 11.

the dimensions of the faces and their number. For example, let each face be 2½ inches square. Draw one of the faces and let it represent the front face. Immediately above and below draw the top and bottom, and at the left and right, the sides. The back may be drawn beyond one of the sides. Such a drawing is shown in Fig. 11. If cut out and folded along the lines connecting the squares, the result would be a 2½ inch cube.

SHEET VIII.

DEVELOPMENT OF A SQUARE PYRAMID.

At the left-hand side of the sheet draw the top and front views of a pyramid having a base 2 inches square and an altitude of 4 inches. To the right, place the development of the surface of the pyramid. In order to obtain this development it will be necessary first to carefully study the views just made. These show that the pyramid has four sides and a base, and that the sides are equal triangles successively joined together. It will then only be necessary to draw four equal triangles joined together about a point and upon one of the triangles to join the square base. As all of the lines composing the sides of the triangles are equal and as they meet in a point, these sides may be considered as so many radii of an arc of a circle. It will therefore be necessary to find what the length of the required radius is. A top view of one of the sides of the face triangles is shown at A B, and a front view

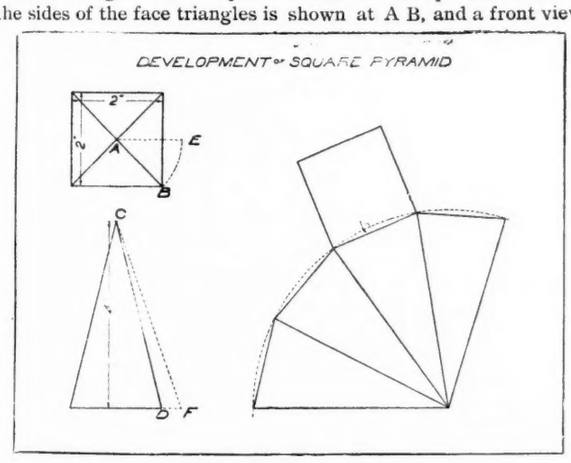


FIGURE 12.

of the same line is shown at C D. But this front view of the line is foreshortened, and it is required to obtain its true length. Imagine the pyramid rotated about its axis so that the line A B would assume the position A E. Then the projection of this line in the front view is C F, which is the true length required This brings out an important principle for the laying out of patterns, in that the true length of each line must be carefully ascertained. The technical statement of this principle is, that the true length of a line is shown when it is parallel to the plane of the paper upon which it is supposed to be projected. For example, the line C D may be imagined as having the end C in the plane of the paper, and the end D as sticking up from the paper. This is shown by the projection of C D in the top view as A B. On the other hand C F may be considered as having both ends in the plane of the paper, or parallel to it. This again is shown by its projection in the top view as A E. It will be simpler and sufficient for our purpose to remember that the projection of the true length of a line will show as a horizontal line in the top view. Too great emphasis cannot be laid upon this point.

Having now found the true length of a side, C F, this length is taken in the compasses and an arc of indefinite length is described. From some point in this arc as a center, and with a radius equal to a side of the base, an arc is drawn cutting the first arc. The two points are joined by a chord which represents the base of one of the triangles. This base line is laid off four times and the various points joined to the center of the arc. Upon one of the chords a 2-inch square is erected, completing the pattern.

SHEET IX.

DEVELOPMENT OF A TRUNCATED HEXAGONAL PRISM.

Draw the top and front views of a hexagonal prism, each face of the hexagon being 1⅛ inches, and at 2½ inches from the base, measuring along the left-hand edge, pass a cutting plane making an angle of 45 degrees with the base. It is further required to develop the entire surface of the frustum thus formed.

As the sides of the hexagon are equal, their development will be a line six times 1⅛ inches long. Therefore, draw a line 6¾ inches long as the base line of the pattern, and for convenience in pro-

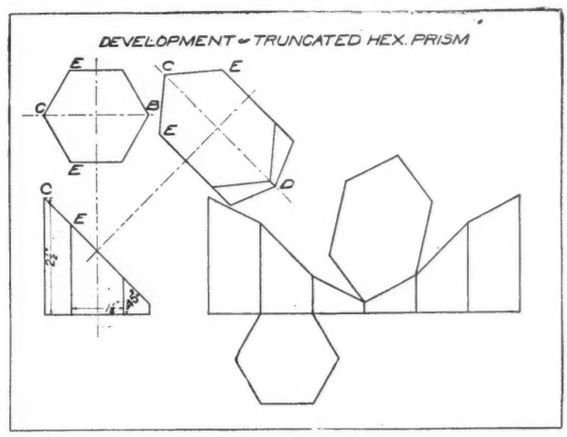


FIGURE 13.

jecting let it be in the continuation of the base line of the prism. Divide this line into six parts of 1⅛ inches each, and at the points of division erect perpendiculars. On these lines cut off distances equal to the cut edges of the prism. This may be done directly by projection from the front view of the prism. Successively connect the tops of the cut lines. Attach a regular hexagon of the required dimension to one of the sides. The pattern is now complete except adding the top. In order to find the true shape of the top it will be necessary to make a view at right angles to it in the front view already drawn. Draw a center line at right angles to the cut face, and at some point in this center line draw another line at right angles to the first. This latter line is shown as C D in Fig. 13. From C and E in the front view project lines at right angles to the cut through C and E, E in the oblique view. Having projected the line from E of the front view, it will be necessary to determine the positions of the two points E, E, on this line. By remembering that the line C D is only another position of the line C B, it will readily suggest itself that the distances of E, E from the lines C D and C B must be the same in both instances. The fact should be strongly impressed, that distances above and below the center line of the top view are the same in whatever position we may rotate the view about the front view. We have already observed this relation as existing between top and side views. It also holds for all intermediate positions. As the point C is on the center line in the top view, it will be on the center line in the oblique view, as will also be the point B. The positions of the points E, E being determined, the

remaining two points are obtained in a like manner. The points thus found are joined in their regular order. It now only remains to transfer this view of the cut surface to the rest of the pattern. Select any side as a connecting side. Then, as any point is determined from its distance from any two other points, each of the corners may be located by two intersecting arcs, the radii of which are equal to the distances from any two points previously found.

SHEET X.

DEVELOPMENT OF A 2×4 INCH CYLINDER.

Draw the top and front view of the cylinder to the given dimensions. As the circumference of a circle is 3.1416 times the diameter, the quickest way to lay out the development of the cylinder would be to draw a rectangle 3.1416 times 2 inches long and 4 inches wide, and add a 2-inch circle on either side. This would do for a plain cylinder, but where it is required to cut off a part of the cylinder and show the developed surface of the cut-off part, it will be found necessary to adopt a different plan. The general procedure is to divide the top view into any number of parts and step off these parts along the line of the development. In the accompanying drawing one half of the top view is shown divided into twelve equal parts, therefore twenty-four of the parts are laid off for the development. The divisions of the top view are projected along the front view as elements of the cylinder. A supposed cut is shown in the drawing by construction lines, and the development of the cut is shown on the pattern at the right. This latter is obtained directly by projection. Imagine the elements of the cylinder numbered from left to right and the elements of the pattern correspondingly numbered. Then with the T square project the intersection of the first element of the cylinder with the cut, across to the first element of the pattern. The intersection of the second element with the cut is next projected to the second element of the pattern, and so on until the center element of the pattern is reached. As the cut is the same at the back of the cylinder as in front, the right-hand side of the developed curve will be identical with the part already found, only reversed. Draw the curve in free-hand with pencil, and ink with the aid of the scroll.

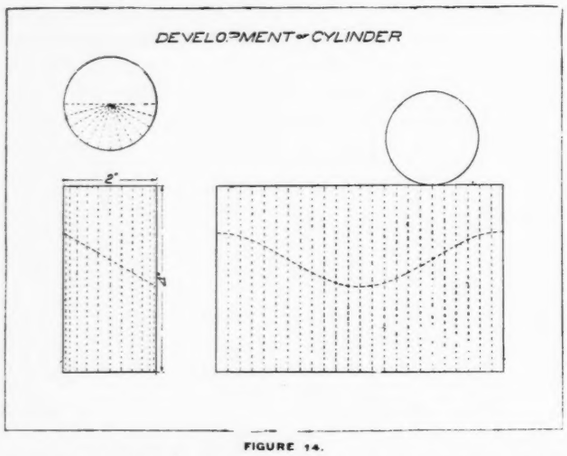


FIGURE 14.

The true shape of the face of the cut is an ellipse, and may be found by the method shown in Sheet IX., for finding an oblique view. For the sake of the symmetrical appearance of the sheet the bottom of the cylinder is not shown in the pattern.

SHEET XI.

DEVELOPMENT OF A CONE.

Draw the front and top views of a cone having a 2-inch base and 4-inch altitude. As in the case of the cylinder divide the circle in the top view into a number of equal parts and project these divisions upon the base line of the front view. Connect these projected points with the apex of the cone. To the right of the cone describe an arc having a side of the cone as radius and the apex as center. On this arc lay off the development of the circle in the top view by stepping off the same number of equal parts as there are divisions of the circle. Connect each of the extremes of the stepped-off arc with the apex. By drawing a circle equal to that of the top view, tangent to the arc, the pattern of the cone is completed.

If it is required to obtain the development of the frustum of a cone, the cut may be developed in the manner shown in Fig. 15. From the points of intersection of the cut with the various elements of the cone draw lines parallel to the base cutting a side line. The true lengths of each of the cut elements are thus obtained. With the apex as center, and with radii equal to the distances to each of the points found on the side line of the cone, describe arcs cutting the elements of the developed cone. The process is identical with that used in developing the cut of the cylinder, excepting that the points are projected by concentric arcs in the case of the cone and by parallel lines in the case of the cylinder.

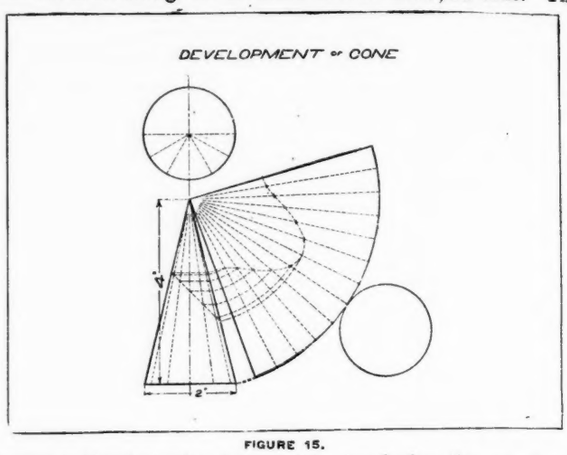


FIGURE 15.

As in Sheet X, the true shape of the cut face is an ellipse, and may be found by the method referred to.

EXERCISES.

EXERCISE 7.—DEVELOPMENT OF A RECTANGULAR BLOCK.

Draw the development of the surface of a rectangular block, 3 inches long, 2 inches deep, and 2½ inches high.

EXERCISE 8.—DEVELOPMENT OF A RECTANGULAR PYRAMID.

Draw the top and front views, and the development of the entire surface of a pyramid having a rectangular base 2½×2 inches and an altitude of 4 inches.

EXERCISE 9.—DEVELOPMENT OF THE FRUSTUM OF A SQUARE PYRAMID.

At half the altitude of the square pyramid of Fig. 12, make a cut at 45 degrees to the base and develop the frustum thus formed. It will be necessary to show the cut in the top view, and this may be obtained by projecting the intersections of the cut and sides of the pyramid to these sides as shown in the top view, and by joining the points thus found.

EXERCISE 10.—DEVELOPMENT OF AN ELLIPTICAL CYLINDER.

Draw the top and front views, and the development of a cylinder having an altitude of 4 inches, and an elliptical base, the major axis of the ellipse being 2¼ inches and the minor axis 1¾ inches. Cut the cylinder by a plane and develop the cut. A simple method of drawing a true ellipse, when the major and minor axes are known, is shown in Fig. 16. Let A B be the major axis and C D the minor axis. On a slip of paper lay off E F equal to one-half A B, and G F equal to one-half C D. Then keeping the point E always on the line C D and the point G always on the line A B, the point F will describe the required ellipse. Find a number of positions of the point F and through these points draw the ellipse.

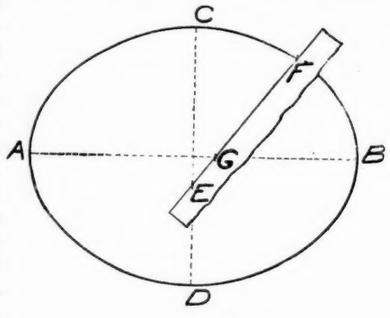


FIGURE 16.

EXERCISE 11.—DEVELOPMENT OF AN ELLIPTICAL CONE.

Draw the top and front views, and the development of a cone having an altitude of 4 inches, and an elliptical base, the major axis of the ellipse being 2¼ inches and the minor axis 1¾ inches. Cut the cone by a plane and develop the cut.

* * *

THE *National Car and Locomotive Builder* and the *American Engineer and Railroad Journal* have consolidated, with Mr. M. N. Forney and Mr. Waldo Marshall as editors. We trust the change may be beneficial and offer our best wishes for a prosperous future.

NOTES FROM FOUNDRY AND SHOP.

ABOUT CORES.

ROBERT GRIMSHAW.

Where a core cannot be vented from the top, there should be laid a good-sized pipe in the mould-bed just below the position of the core, and the latter should be well fastened down—a top chaplet answering in green or dry sand.

Where a core is vented through the side of a mould, whether it be a sand or a loam mould, the core should be well fastened down by a bolt or stirrup where attached to the core-iron, else the kick back may tend to displace the core laterally. Care should be taken in pouring to see that the core-vents burn clear and blue, not yellow, a yellow flame usually indicating that the vent is stopped with metal. The yellow flame is caused by metal reaching the chaff, straw, ashes coke or other material in the interior of the core.

The colder the metal is run, the more it will need venting. If it is hot and lively it will be able to flatten itself against the mould-wall even against the pressure of the gases which are trying to get out through the pores of the core; but if it is sluggish there will be much less difficulty in a current of gas making an impression on the surface of the metal, and the result will be a poor surface.

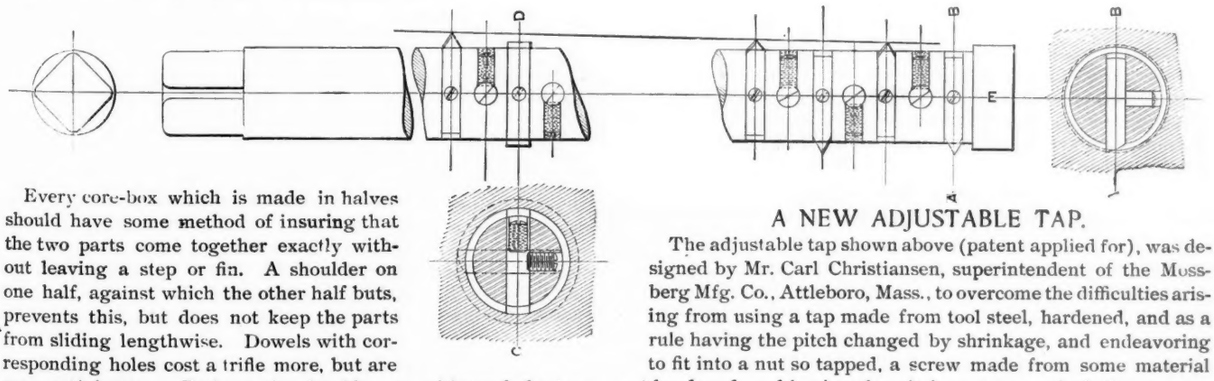
Some shops which are not well fitted with boring apparatus will core holes in lugs, fins or flanges, instead of casting them solid and boring the holes. Very often in such case the hole will have its sides blown by reason of the cores not having been properly vented, or having been wet, or for some other reason the work of coring being defective. A defective place in a lug having a hole by which a heavy piece is to be lifted, may cause a serious or even fatal accident.

The use of chaff or straw for venting cores has been adopted for the reason that they make a lighter core, and that in making it, it is somewhat easier to get the proper outline; but they are not quite so safe as those vented with ashes. There is more danger of spoiling the casting by the metal breaking through, with chaff or straw rope in the inside than with ashes, which do not permit the metal to get so far.

Burning together the two parts of a broken core-tube is done by making a core of an outside diameter equal to the inside diameter of the tube, and about a foot long, sticking one end of it in each of the two ends that are to be burned together, and bringing the parts nearly in contact as they are to be, leaving about an inch between them, then making a two-part outside mould with three gates in it, by which the metal may be poured in at one end on the top, through one hole, and run out at the other; then the manner of pouring may be reversed and the metal run the other way. Two or three such pourings and reversals will melt the ends of the tube, and they will be found burned together in a joint which is stronger than the original juncture.

Core-tubes that have got bellied may be straightened by peneing; but it will be found that after they have been straightened once or twice, peneing no longer has any effect on them; then the only thing to do with them is to break them in two in the center, put the two former ends together for a new center, and burn them together.

In making round cores in halves the two parts should be put together with a clay slip about as thick as cream.



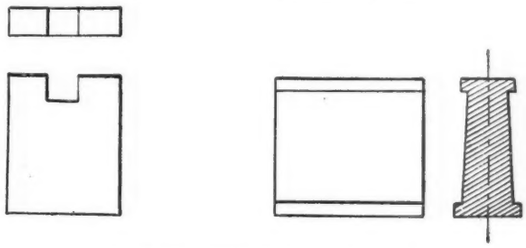
Every core-box which is made in halves should have some method of insuring that the two parts come together exactly without leaving a step or fin. A shoulder on one half, against which the other half buts, prevents this, but does not keep the parts from sliding lengthwise. Dowels with corresponding holes cost a trifle more, but are more satisfactory. Perhaps the shoulder, to withstand the tendency to crosswise sliding, and one pin to keep the parts from sliding lengthwise, will be found best for most cases.

For sweeping up loam cores on barrels, there should be a trestle having semi-circular bearings in which the core-center may be rotated, as journals; then there should be a straight-edge, longer than the core is to be, and having an edge beveled almost down to an absolute line; this can be used to strike the entire length of the core at once by turning the latter in its bearings. If there is no squared end on the core-center on which to put a crank-handle, a handle may be put on by clamping.

There are places where a cored passage is very tortuous, where it is difficult to get out the cores, and in such cases there should be left hand-holes about three inches in diameter, the metal around which should be of extra thickness (the reinforce coming on the inside), so as to prevent the existence of these holes making any likelihood of the wall of the castings giving way at this point, and also to permit the holes to be plugged up by shallow screw-plugs, if this be desired.

GAGE FOR CUTTERS OF NUT MILLING MACHINES.

In that class of nut-facing milling machines in which the nuts are strung on a mandrel and two opposite faces milled simultaneously by passing between two rotating cutter-heads with axis nearly at right angles to the mandrel, and a circle of cutters parallel with the axis, it is absolutely necessary that all the cutters



GAGES FOR CUTTERS OF MILLING MACHINES.

on each head shall project exactly the same distance, in order that each cutter shall get its share of the work, and only this; and that the milled work may be free from scores or any other kind of tool marks.

In order to effect this, the usual method is to have a gage-piece consisting of a metal block having one end truly plane, and in this end a square notch large enough to admit a cutter and as deep as it is desired, to allow each cutter to project.

All the cutters being first set too far out, they are pushed back by the gage, and then each is held by its set-screw; a work requiring some time and in which occasionally one cutter is skipped, leaving it projecting too far and scoring the work.

In place of this, I suggest such a gage as shown in Fig. 2; consisting of a wedge-shaped plate, having the sides of any vertical section parallel, and in horizontal section having as much taper as the faces of the cutter-heads are inclined horizontally to give clearance to the cutters.

Two vertical projections on each side, as high as it is desired to let the cutters project, will touch the flat face of the cutter-head; and the plane but not parallel surfaces between will truly gage the projection of all the cutters at once.

This gage may best be made by the machine at once; the wedge shape being given by running it through vertically.

* * *

A NEW ADJUSTABLE TAP.

The adjustable tap shown above (patent applied for), was designed by Mr. Carl Christiansen, superintendent of the Mossberg Mfg. Co., Attleboro, Mass., to overcome the difficulties arising from using a tap made from tool steel, hardened, and as a rule having the pitch changed by shrinkage, and endeavoring to fit into a nut so tapped, a screw made from some material not hardened, and having the pitch as true as the lathe can produce. The difference between the two threads is often considerable, and the result is an incalculable amount of expensive fitting.

To make this tap, select any piece of soft steel and turn it to one-eighth of an inch less diameter than the bottom of the thread, or on small taps as much as is thought best to give enough clearance for the chips. With a thread tool make a line on the steel rod the pitch which is to be cut, the lathe being geared up in the usual way. Next a pointed tool is put in tool-post, and four lines scribed lengthwise of the tap parallel with its axis, dividing its circumference in four equal parts. At the intersections of spiral line with the last named four lines, holes are drilled for tool steel pins, which are held by set screws as at A B. To prevent pins from turning they are flattened or drilled into for set screws. To prepare the tap for cutting, insert all the pins required to cut a full thread, and distribute same along the rod such a distance apart that there will not be too many cutting at once in the nut. The ends of the tool steel pins or cutters are now shaped in the same manner that a thread is usually cut on any tap. Before taking cutters or pins out to be hardened, they should be numbered to their places, making it of no importance to have the holes drilled accurately on the spiral or even through the center of the rod At a number of places between the cutter pins, other holes are drilled, and tool steel pins driven in and turned off in place, to the diameter of bottom of thread, and the same diameter as the end of tap at E. These furnish a rest or guide to keep the tap concentric, thus by cutting both tap and screw in the same lathe, the pitch of both will be alike and good fits can be easily obtained.

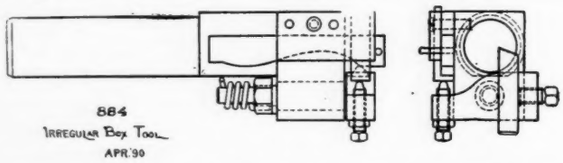
* * *

TAPER TURNING TOOLS.

In response to an inquiry last month we requested Mr. James Hartness, of the Jones & Lamson Machine Co., who has had more experience in this line than any one we know of, to furnish us with illustrations of his devices. His reply follows:

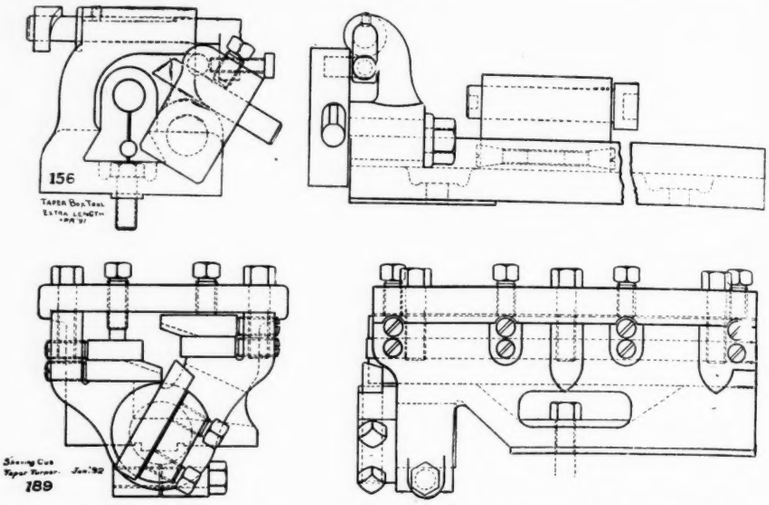
Herewith I hand you blue prints of various styles of taper turners, also a copy of 5th edition of "Rapid Lathe Work," which contains cuts of the two styles of taper turners mostly used on the flat turret lathe.

One of the turners is designed exclusively for working on bolt forgings, such as locomotive frame bolts, and employs a special chuck. This chuck is known as the wabble chuck, a blue print and cut will be found showing its form. Blue print No. 884 shows our original turner, as used in the high turret machine for irregular work, or very short taper work. For long slender tapers this turner is slightly modified to give a greater leverage of the former over the cutting tool, and also to hold the round bushing for supporting the work. Blue print No. 290* gives various views of our



railroad turner for turning locomotive frame bolts. This is used in connection with the wabble chuck. No. 160 is a multiple cutter taper turner for the same class of work. It may also be used on straight work, or even for shoulder work, where there are a great number of pieces of exactly the same dimensions. No. 156 is a turner that was used for turning long tube expander mandrels. It is substantially the same as our railroad turner, excepting that a sliding center support for the outer end of the work is used instead of a back rest, and a flexible chuck is not required for this turner. No. 157 is one form of the pencil sharpener scheme for turning taper pins. No. 189 produces a shape that resembles a taper, but it is actually a series of cylindrical sections of slightly varying diameters. The turning tool at the front only removes the scale and produces a cylindrical form. The tapering is done by edges that resemble a very coarse lathe, or mill file, and the cut of each edge is a shaving cut.

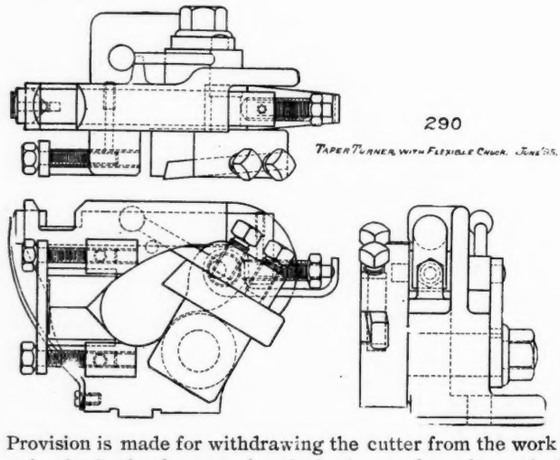
The turners shown by turners Nos. 157, 160 and 189 require considerable patience and skill in use, but No. 160 is probably the fastest working taper turner now made. It will be observed that instead of a single cutter being used, there are a number of cutting edges which may be almost indefinitely increased as the length of work increases, and that it is necessary to feed only



about 1-inch instead of 6-inches in turning the 6 inch bolt, but if the turner was made in a 12-inch length, the 1-inch of travel would turn the whole length of a 12-inch bolt and thus make a very great saving.

For every day use, however, it has been found that one cutting edge is quite enough for the operator to watch, and hence the much larger use of the turner shown by blue print No. 290. In all the taper turners shown, excepting No. 189 and No. 157, a former is used to effect the diameter produced and the point of swing of the tool is caused by it, to travel in substantially a radial line on the work. In No. 160 the former is made a part of the tool and actuates the back rest as well as the cutting tool. In all of the others the back rest is fixed. If the back rest follows the cutter as in the case of No. 290, it is necessary to use a chuck that will allow the outer end of the work to move laterally, and that is why the flexible or wabble chuck is required. When the back rest precedes the cutter, as No. 290 is frequently made, then the work is previously turned to a cylindrical form to give a true surface to the back rest.

The former or template which actuates the cutters is swung loosely from one of the cap bolts of the main bearing of the spindle. When the turner is in use, this former is swung into such a position that the end will enter the notch in the upper part of the turner, so that its varying width will move the plunger, which in turn acts upon the cutter.



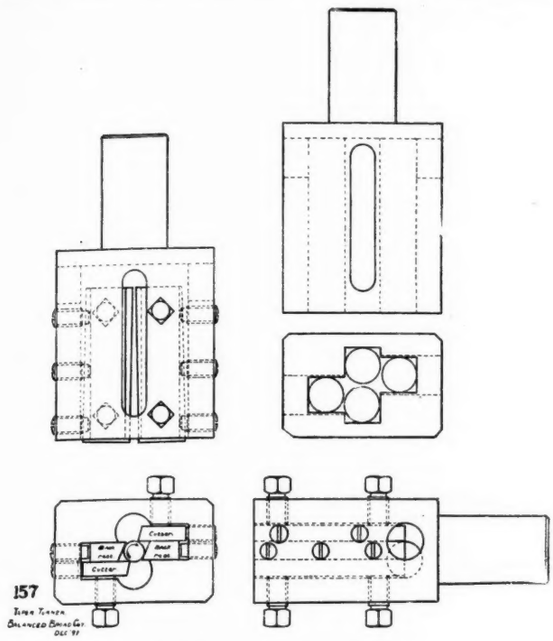
Provision is made for withdrawing the cutter from the work in running back, also for removing the back rests from the work, the same as the regular turners of the flat turret lathe.

It is believed that the writer's patents fully cover the use of a swinging tool in the taper turner, also the multiple cutter turner No. 160. No. 157 is a new form of the old pencil sharpener scheme, which is very commonly used.

The state of patent on No. 189 is not clearly understood. Ap-

* A half-tone of this will be found on page 181.

plication for patent was made, but was rejected because a similar tool had been used in an English broaching machine, which bears a little resemblance in the end view, but the action, of course, was very different. No. 184 has become obsolete excepting for very



TAPER TURNING TOOLS.—PAGE 176.

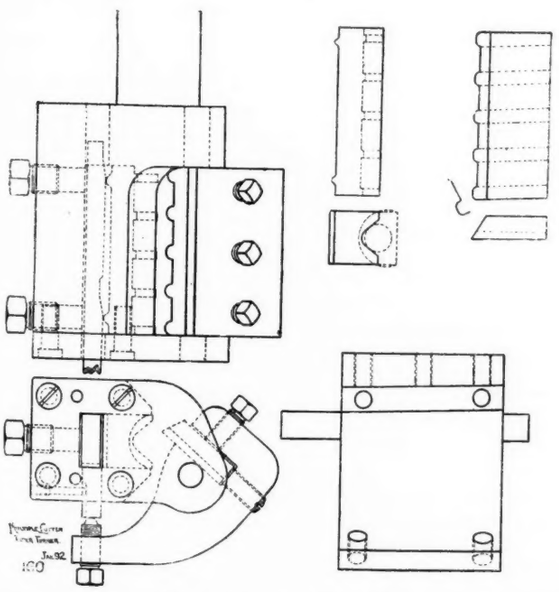
rare cases, in fact the broad tool is now used for nearly all taper and irregular work that does not exceed, in length, three or four times its diameter."

ALFRED ELY BEACH.

Mr. Alfred Ely Beach, one of the members of the firm of Munn & Co., publishers of the *Scientific American*, died of pneumonia on January first at seventy years of age, having been connected with that publication since 1846. He was well known as an inventor, a mechanic and a journalist.

The work of editing the *Supplement* fell on his shoulders and was carried out largely as a labor of love, it being his particular charge in which he took extreme delight. It is impossible to give the credit due him in such brief space, and his work will give a better idea of his worth than anything we might say. Our contemporary, as well as its many readers, loses a valued friend and adviser.

* * *



TAPER TURNING TOOLS.—PAGE 176.

After numerous changes during the past year, our well known and interesting contemporary, the *American Machinist*, has passed into new hands, with Angus Sinclair as president, John A. Hill, treasurer, Fred J. Miller, vice-president, and C. A. Hansmann, secretary. Mr. Fred J. Miller continues as editor-in-chief, assisted by Mr. Frank Richards and Mr. Frederick A. Halsey, all being well known to the mechanical world. Beginning with volume XIX., it is the standard size of 9×12, has twenty-six reading pages, and inaugurates a department devoted to electrical machinery. Judging from Messrs. Sinclair and Hill's management of *Locomotive Engineering*, the future of the *American Machinist* is brighter than ever, and as the boy said to his schoolmate, we congratulate it on the choice of parents.

* * *

PROPORTIONS OF HIGH SPEED ENGINES.

The following gives in brief the results obtained by Prof. John H. Barr, of Cornell University, assisted by F. F. Gaines and H. E. Williams, to determine the practice of builders of high speed engines in proportioning the main parts. The data was obtained from about twelve builders and covers about 75 engines which range in size 25 to 225 rated HP. The paper was presented at the last meeting of the A. S. M. E. in New York.

The following notation was used throughout this paper:

D = diameter of piston; A = area of piston; L = length of stroke; S = steam pressure, taken at 100 pounds per square inch above exhaust, as a standard pressure; HP. = rated horse power; N = revolutions per minute; C = a constant. All dimensions in inches, unless stated to the contrary. Other notation is explained as used.

For diameter of main shaft at bearings, the results were:

$$d = 7.56 \sqrt[3]{H.P. \div N} \text{ for the mean,}$$
$$= 8.76 \sqrt[3]{H.P. \div N} \text{ for the maximum.}$$
$$= 5.98 \sqrt[3]{H.P. \div N} \text{ for the minimum.}$$

where d = diameter of shaft at bearing.

For example: If an engine develops 100 horse power at 250 revolutions per minute, the first of these formulas gives

$$d = 7.56 \sqrt[3]{100 \div 250} = 7.56 \sqrt[3]{.4} = 7.56 \times .737 = 5.57 \text{ inches, or say } 5\tfrac{1}{2} \text{ inches.}$$

Connecting rods were rectangular with breadth equal half the height, and b (breadth) was found to be

$$b = C \sqrt{D\,L}$$

C varying from .0433 to .0693 with a mean of .0545.

Piston rods were found to be

$$d = C \sqrt{D\,L}$$

and C varied from .119 to .177 with a mean of .145. The projected area of main bearing gives $d\,l$ (diameter × length) = C A and C ranges from .361 to .739, with a mean of .489. Calling p the pressure per square inch of projected area, $p = \frac{S}{2\,C}$ which with C as before gives about 100 pounds pressure per square inch as an average.

The projected areas of the crank pins were found to be represented by the expressions:

$$d\,l = .22 \text{ A for the mean.}$$
$$= .07 \text{ A for the minimum.}$$
$$= .44 \text{ A for the maximum.}$$

These values give pressures per square inch of projected area (for steam pressure of 100 pounds per square inch of piston), as about 450, 1,400 and 225, mean, maximum and minimum, respectively.

There is a wide difference in the ratio of diameter to face of piston as might be expected. The following formulas were obtained:

$$\text{Face} = .437 \text{ D, for the mean.}$$
$$= .300 \text{ D, for the minimum.}$$
$$= .650 \text{ D, for the maximum.}$$

These formulas are, of course, purely empirical.

Crosshead pin.—Projected area of crosshead pin varies from .066 A, to .346 A; the mean value, as observed, being about $d\,l = .105$ A.

The length of crosshead pin was found to vary from d to $2d$; the mean being $l = 1.33\,d$.

Fly wheel.—The weight of rim, W, should be proportional to $\frac{\text{H.-P.}}{D^2\,N^3}$ (in which D is diameter of wheel in inches), for engines on similar service, steam distribution, etc. A wide range of

weights is to be looked for here, and this expectation is justified by the examination. The expressions obtained are:

$$W = 833{,}000{,}000{,}000 \frac{\text{H.-P.}}{D^2 N^3} \text{ for the mean.}$$

$$= 341{,}000{,}000{,}000 \frac{\text{H.-P.}}{D^2 N^3} \text{ for the minimum.}$$

$$= 2{,}780{,}000{,}000{,}000 \frac{\text{H.-P.}}{D^2 N^3} \text{ for the maximum.}$$

As in the other cases, the general practice lies comparatively close to the mean; the extreme values of the constants covering the widest range observed, which is approached by but few of the engines examined.

The linear velocity of rims of wheels was treated thus: The average velocity of each maker was found, then the mean of these averages was determined. This general mean is about 4,200 feet per minute.

Weight of reciprocating parts.—For engines having similar compression, smoothness of running (in passing the dead points) indicates that the weight of reciprocating parts, W, should be proportional to $\frac{D^2}{L N^2}$. Taking the reciprocating parts as made up of the piston, piston-rod, crosshead and one-half the connecting-rod, the result was obtained by plotting the weight of these parts as abscissas, and the corresponding values of $\frac{L N^2}{D^2}$ as ordinates. By using the reciprocal of $\frac{D^2}{L N^2}$ for y, the mean curve takes the form of the equilateral hyperbola, $xy = C$. and the value of C is found to be 1,850,000; hence

$$W = 1{,}850{,}000 \frac{D^2}{L N^2}.$$

The weight of entire engine per horse power in the engines examined is given as $W = 117$ (HP.-7) or $W = 117$ (HP.)-820 pounds.

* * *

SETTING ENGINE BEDS.—FLINTS.

W. H. Booth.

I am reminded by the article in a recent issue of your paper that there is another side to the question as to what is the best way to fix an engine bed upon its foundation. In my younger days there was no question as to the superiority of lead, iron, cement or grout, for not one of these articles was thought of for a minute. An engine bed was not planed on the under side, but any serious lump or particularly projecting roughness would be dressed off with the chisel. The foundation was massive masonry of coarse grit as a rule and was left by the masons in a generally level condition. The engine bed was laid down upon this and adjusted approximately in position and its plan lined off on the stone with an ample margin. This area was then dressed off to a smoother surface, the casting again laid down and pushed by means of levers back and forth a few times over a distance of two or three inches. This done, we next tested its condition by the spirit level laid across some planed portion of the upper surface, such as the slides, and we then lifted the bed sideways and dressed off the blackened surface of the masonry where the rubbing had been most severe, giving most attention to the portions to be reduced to make the casting level on its upper surface.

As soon as this essential was secured, the further reduction of surface did not as a rule demand more than mere scraping with a chisel, but the rubbing of the bed to and fro, and always in a longitudinal direction and finally to the extent of only about an inch, was continued until the surface of the stone was very evenly blackened by the casting all over the rubbed surface. The surface of the masonry was then brushed free from dust, the bed fitted to exact lines and the bolts inserted and screwed up, and there was then never any doubt as to the condition of the cement or whether the grout had run in as it should do. Nor did the work occupy so much time as it might be expected it would do, and when done the work was good and sound and a close metal to stone fit was secured that could not fail. Possibly, after the engine had run a few days the nuts of holding down bolts would bear an eighth turn as a final tightening up and there the work would remain good forever. I believe all the early steam engines of Boulton and Watt and others were thus laid down.

In a beam engine there were three foundations to prepare, namely, the cylinder wall or pier, which was built across the engine house, the crank bearing wall, which ran longitudinally and the pier, which carried the pillars bearing the entablature beam, this beam carrying the bearings of the working beam and being tied into the side walls of the engine house. In the dressing off of these various foundations the final levels would not be in strict accordance with the intended dimensions of parts, and it was the practice to leave the finishing of the piston-rod to the last, and when the engine was set up and the long connecting-rod hung in place there was made a wooden staff, reaching from the bottom of the cylinder to the crosshead, and on it was marked the cotter hole of the crosshead, this staff being sent to the shop to enable the piston-rod to be finished to exact length.

It will be obvious that the beam engine was strictly dependent upon the weights of the various piers and walls of its foundation for the work it could be called upon to do, the weight of each part being greater than the steam pressure × area of piston. Indeed, the middle or pillar wall had to be doubly as heavy as the cylinder and crank wall, and for this reason the ends of the entablature were weighted by being let into the engine house walls. In process of time, as steam pressures increased, the foundations of a beam engine often proved insufficient in weight and were sometimes added to, but it was no unusual thing to see the pillar wall lift a little at each up stroke of the piston.

There was a sort of reaction from these heavy foundations when horizontal engines were introduced. These would "do perfectly well without a stone quarry under them," and were in some cases merely given a thin bed of stone or brick, but somehow the heavy foundation appears to have a certain virtue of its own, and the underwork of a modern factory engine is fully up to weight, and I suppose that, go where you will, there will be found a general sameness in the foundations of heavy machinery much as there is so much likeness in the stone implements of ancient man. To a non-professional eye there is no difference in the appearance of a worked flint whether from Brandon Heath, in Suffolk, or from Egypt.

My brother has just brought home a lot of flints from Egypt as well as many relics of a civilized race, who seem to have been temporary sojourners in the country about the time of the early Pharaohs, only a few thousand year's since, and these relics are very curious and interesting, especially in the line of crockery, of which large numbers seem to have been always deposited in the tombs and are recovered sound and whole. But to return to the flints. I know a man who has tons of these he has picked up all over the world, in both hemispheres, and to the ordinary eye they are all alike, all designed in the same lines. But the connoisseur in flint implements will range them in a definite order and profess to point out variations which "show infallibly" a certain progress in design, and will descant for hours on exceedingly minute differences from which they will almost tell you the particular breed of the last chicken that the flint was employed to dismember. Assuming that the chief use of a worked flint was to cut up an animal or make holes into your neighbor, it is difficult to see how, with nothing but a stone or other flint as a forming tool, any other form but the ordinary standard form could be evolved. I find all sorts of shapes inferior to the recognized perfect form, but they bear the same family resemblance, and the fact that we find these worked flints beneath layers of deposited gravel may be taken as evidence of their enormous age. We know nothing of the extent of the intercommunication between different parts of the world in palæolithic days, but it may have been considerable, and no doubt there were long ages for communication to be established in, but is there any greater reason to wonder at the similarity of flint tools than at the similarity of steam engines or hand hammers, or where less artificial materials are employed in the form of chimneys.

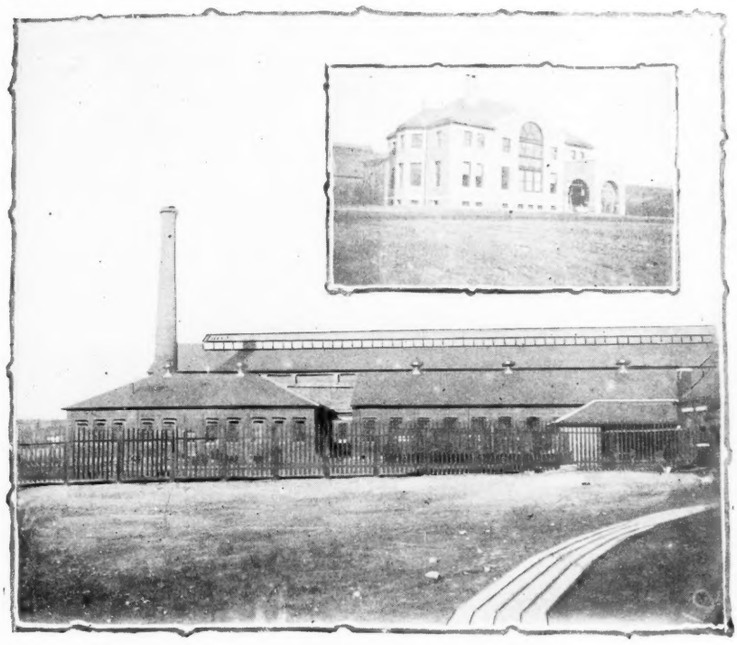
* * *

The Shape of Plumb Bobs.—These should be of flat turnip shape, in order to make them come to rest sooner. This is because every rotating body tends to rotate about its shorter axis; and if the long axis of the plum-bob be in the line of the cord, it will tend to turn about its shorter axis, and hence will wobble. There should of course be a fine point at the bottom in order to properly center or right it.

THE SESSIONS FOUNDRY CO.

It seems rather strange in many ways to find an extensive foundry plant tucked away in the Connecticut hills at Bristol, and stranger yet to find a new plant, equipped in the most approved manner, thrown open for inspection and business.

The general appearance of the buildings can be obtained from Fig. 1, the office building in the corner being of granite, the picture product of a pocket kodak, as are some of the other small



THE BUILDINGS.

views. The office speaks for itself and needs little comment. The second floor is for the drafting room. Pneumatic tubes are provided for transmission of messages between main offices and superintendent, shipping clerk, etc. A complete private telephone system is provided, by the United States Telephone Construction Co., Philadelphia, Pa., which connects with all parts of the plant, and affords ready communication between departments. The main foundry building is 110 feet wide, 530 feet long and 55 feet high at center, a skylight 20 feet wide running the entire length of building. Ample light is provided, as shown by interior view. A wall about 5 feet high, with several openings to allow passage, runs nearly the whole length, and to this the moulding tools and benches will be fastened, and probably moulding machines for some of the work. At the further end is a large sand pit, where the heavy castings will be made, this being provided with two hydraulic jib cranes, made by R. D. Wood & Co., Philadelphia. One of the many hose boxes, built over the fire hydrants, is shown in this view. A 25-ton electric travelling crane, by the Morgan Engineering Co., Alliance, Ohio, controls the entire center of foundry, making handling of heavy material an easy matter. On each side of the building is a track for push cars, which can be switched to any part of the buildings.

There are four cupola rooms, each for two cupolas, the blowers being located in the second story of the cupola rooms, being driven by electric motors. The toilet rooms are a special feature, being the most complete the writer has ever seen in a foundry. There are two double rows of marble wash bowls provided with hot and cold water, three shower baths, independent lockers for each man as far as possible (those not provided here are accommodated in the main room, as seen by the lockers on the walls). The small view in center shows the plumbing better than the other; the shower baths are also shown. There is also a special line of piping for drinking purposes, spring water being provided for this purpose. In addition to this there are auxiliary toilet rooms, so that no one has an excuse for leaving the place without cleaning up.

Careful attention has been paid to heating, the B. F. Sturtevant Co.'s system being employed. A twenty-horse engine drives the blower of this system and drives the air through a 78-inch main to smaller pipes for distribution. The heating problem is quite a serious one, there being about 3,000,000 cubic feet of air space to be heated. The main heating pipes are shown in the small view in corner of foundry interior.

The power plant consists of four Heine boilers, two Harris-Corliss engines, four Eddy dynamos (two for power and two for lighting), and the switching engine Jo-Ken, by the Baldwin Locomotive Works, being perhaps included under this heading.

The machine shop is 60 by 80 feet, the pattern building 50 by 100 feet, and the shipping building 80 by 300 feet, which also contains the rumbling rooms, for cleaning castings.

The engineers and architects were Davis and Barnes, of Philadelphia, while Coffrode & Taylor, of Pottstown, Pa., furnished the 760 tons of structural steel used in the construction. Everything is arranged to handle material, from scrap (of which they have about 3,000 tons on hand) to finished product, with the greatest facility and economy, it being recognized that this is an important feature, and economical arrangement is the watchword of the whole plant.

* * *

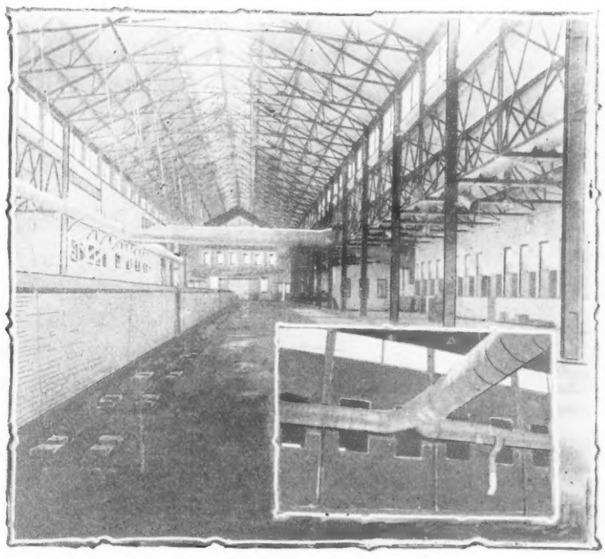
BLOW-OUT PIPES ON BOILERS.

W. A. CARLILE.

At first sight it would seem that there was nothing particularly interesting about the blow-out pipe for boilers. There is little variation in the position of the pipe, or in the material of which it is made, and it has only one function, which is to blow water out of a boiler. Having said so much, the subject, to some, might seem to be exhausted. Let us see if it is so.

These pipes in horizontal boilers are as a rule attached to the bottom of the shell, near the front of the boiler. A block is riveted on the shell. The pipe is bolted to this, and at the other end of its bend is the blow-out cock. The arrangement is simple enough, and yet these fittings give a great deal of trouble in many cases.

The most obvious of these are leaks, which lead to corrosion on the shell externally. These leaks are evidently caused by straining of the pipe as the boiler expands and contracts. Were the pipe free it would move with the boiler, but in many cases it is not easy to give it the requisite freedom of movement. Where its waste pipe passes to the drain through an opening in the bottom or side of the blow-out pit, the pipe, even if originally left

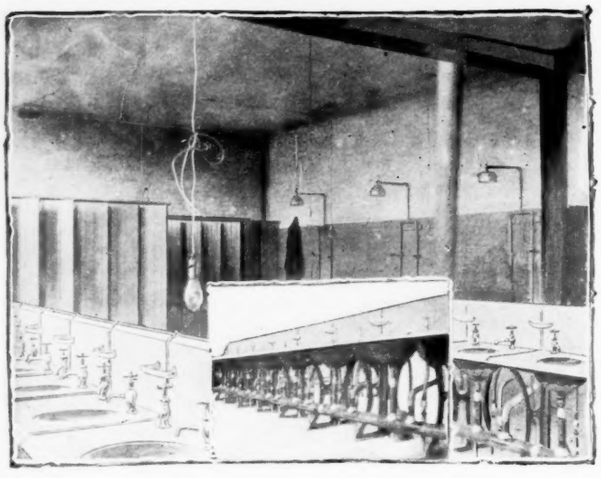


INTERIOR VIEW.—THE SESSIONS FOUNDRY CO.

free in the hole, is liable to become bound by the accumulation of dirt, or fragments of coal or brick-dust around it. If the pipe cannot be altered, then attention to keeping it clean is the only remedy.

But with a range of boilers, the blow-out pipes will sometimes all be attached to a horizontal pipe, which runs along the length

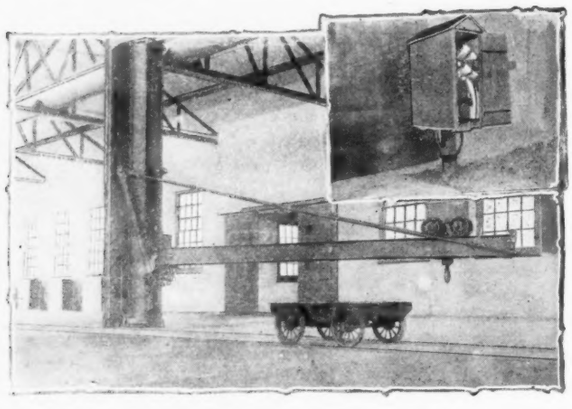
of the range. This arrangement, being a convenient one, is often adopted, and if the horizontal pipe is free at the ends, it would seem to be an excellent plan to have a floating pipe, free to come and go. If all the boilers could always be kept at the same temperature there would be no great drawback to this method. But apart from the fact that there is continual variation in temperature and expansion, we must remember that some of the boilers are often at rest when others are at work. Say one boiler is cold, and one on each side of it is under steam. In that case a bending strain is thrown upon the horizontal pipe, and its resistance to this causes the joints of attachment to the boiler to strain and leak when steam is next raised in that boiler. The hot boilers



TOILET ROOM.—THE SESSIONS FOUNDRY CO.

are also strained at the same time. With a boiler at work and one on each side of it at rest, the result is almost the same. In the case of the cold boiler the pipe is under tensile strain, and the joint is likely to open at the back. With the boiler hot, the strain is compressive, and the tendency is to cause a leak at the front of the joint.

To avoid this straining, the waste pipe of each boiler in a range is sometimes led straight away from the boiler, through the brickwork beneath the foot-plates, with the end of the pipe free and opening into a drain. But if the pipe is long, its own weight acts as a drag, and this has been known to cause straining. The best arrangement seems to be that in which the waste pipe is short,



HYDRAULIC CRANE —THE SESSIONS FOUNDRY CO.

and is passed loosely through the opening of a larger pipe which leads to the drain.

The straining of these pipes does not end with leakage, for leakage means corrosion. Serious accidents have occurred through corrosion on a cast-iron blow-out bend, leading to violent rupture. The danger of a fractured blow-out pipe is very great to the fireman, and fatal results have followed, but it is more far-reaching than this. A pipe breaks. There is a rush of boiling water and a cloud of scalding steam. Everybody gets out of the way. Even if an attempt is made to draw the fires, such drawing may be impossible, on account of the outrushing water and steam. The fires are in full blast, and if they cannot be drawn there may be a collapse of the furnace crowns, and an explosion of the boiler that may wreck the building. Therefore, though these pipes may be out of sight, beneath the foot-plates, they cannot safely be left "out of mind" as well.

One of the worst methods used with these pipes is to build the cross-wall straight across, so that the pipe passes through it. This sometimes causes the pipe to "bind," and the rigidity being so close to the bend, any relief by molecular yielding to the strain is largely reduced. But a more serious matter is that the joint is hidden, so that if the joint leaks, it is not seen, and corrosion may become very deep before it is discovered. Again, a leak from the joint, which might drop clear of the pipe, which in ordinary circumstances could not cause corrosion, may cause corrosion in this case. The damp is absorbed by the brickwork of the cross-wall, and by capillary attraction passes to the pipe, where it goes through the wall. Not only do the bricks conceal this, but they hold the wet close to the pipe, so that cases have been known of deep corrosion taking place at the part of the pipe that passes through the brickwork.

To avoid this, the wall is usually recessed, so that when the floor-plate is lifted the whole pipe can be seen. But there are cases where the wall has been properly recessed, and where another wall has been built across in addition. This encloses part of the pipe in a closed chamber, which is unseen by the attendant. Such building across is resorted to for the purpose of keeping ashes, etc., out of the recess, but its effect is about as bad as if there was no recess at all.

So far we have been dealing with effects that are external to the boiler. But if we look inside when the boiler is at rest, we shall find that corrosion on the blow-out plate is very common. The reason at first is not quite clear. It seems as if the mud in the boiler had a more corrosive action on this plate than elsewhere. As boilers are usually set at a slight slope downward to the front, there should be more mud here, and also more corrosion, if the mud concentrates the corrosive action. But, on the other hand, when a boiler is opened, but not yet cleaned, it will be found that mud is all along the bottom as well as on the blow-out plate. Therefore there ought to be a good deal of wasting along the bottom, if the blow-out plate is severely corroded. As a rule this is not found to be the case, and frequently there is no corrosion at all along the bottom, and a great deal on the blow-out plate. We must therefore look for some other cause than the corrosive action of the deposit.

That cause appears to be in the straining of the plate by the blow-out pipe. In one range of boilers there was frequent renewal of this plate in one or other of the boilers, owing to rapid corrosion going on. The waste pipes were made more free, as an experiment, and there was a marked diminution of the corrosion.

The connection between straining and corrosion seems to be this: Under a strain, microscopic cracks are found, and upon the bright surface of these any acidity in the water rapidly acts. Then there are more cracks, and more corrosion, and the thinner the plate gets the more rapid is the action. An analogous case is that of a chain, where a weak link will stretch more than a strong one. Thus, with a plate, a weak part will yield more to stress than if it were stronger, and the corrosion acts with more and more power as the plate thins.

There are, however, instances to the contrary, or that in which a blow-out plate will corrode to a certain point and the corrosion then be arrested. In such a case there may be a difference in the incidence of the strain, and a thinner plate may have the advantage. If the strain should be a bending one, owing to some peculiarity in the setting, a thin plate would not be so ready to crack on its surface as a thicker one. Then, as it got thinner, a point might be reached where it would not crack at all, and the corrosion would then cease. Such an explanation may, to practical men, seem too theoretical. It is, however, better than no attempt at all at an explanation.

The relation between straining and corrosion is, however, an obscure one, and if the present article should lead others to turn their attention to the elucidation of the problems presented, the purpose of the article will be served.

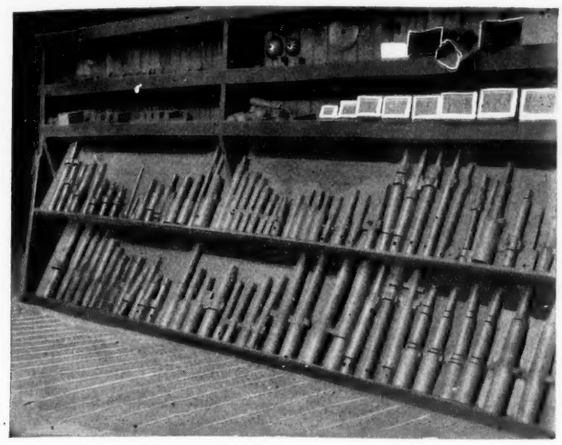
* * *

If the size and quantity of special annual numbers are any sign of prosperity, the year 1896 should be so favored. *Dixie's* Christmas Number *Locomotive Engineering*, 150 pages, the *Iron Age*, the *Tradesman*, 248 pages, the *Iron Trade Review*, and several others, all deserve commendation for their issues.

IN A SMALL TOOL ROOM.

G. E. A. RING.

The tool-maker in a large shop, who has ample room for the tools in his charge, has a fenced-in tool room with a "No Admittance" sign on the door (which no one would see if the door wasn't locked from the inside), and a boy to give out the tools and put them back in place when they are returned, does not appreciate the work of the tool-maker in a small shop, in his endeavor to keep his "corner" looking neat and orderly. The small shop's tool room is usually a "corner" only, sometimes



ARRANGEMENT OF TOOL SHELVES.

fenced in, sometimes not; and as the tool-maker is often busy enough without "playing boy," the men come in and take what tools they want, while the tool-maker keeps his weather eye peeled to see that they put them back in proper place and that they are in good condition.

One of my first jobs after I left the old home shop was as tool-maker in a little shop making brass goods; and I started in to brace things up in my corner, where everything was oily, dirty and upset generally. After getting things cleaned up I found that many of the tools were below size, but as no one seemed to care I decided to let them go until I finished cleaning up the corner, and the places where the tools were kept. I soon found that there was a reason for keeping the tools oiled, for the place was apt to be damp, and bright tools soon rusted. So after wiping the accumulated dust from them they were again oiled lightly and laid away.

A little persuasion, coupled with an offer to do the work myself at odd times, enabled me to have a partition built to keep the brass chips away from those of iron and steel, and also to afford room for tools. These were utilized by putting shelves on the inside in the usual way except for the boring bars and arbors, and ordinary shelves are poorly adapted for this class of tools; they roll against each other, get bruised and nicked, and, if the corners of the cutters strike, are not improved for cutting purposes. So we made the lower shelves very slanting, as shown in the photograph, and by leaving open the space below the top shelf, could run long arbors up under and save room. It was first intended to put light partition strips between the bars, so as to keep them in place, but this was found unnecessary, as their weight and the friction on the shelf would keep them in place unless accidentally moved from place.

It will be seen that the shelves are pretty well utilized, and that milling cutters and shell reamers are hung on the partition. I found that a pair of bellows with good, healthy lungs aided greatly in keeping the shelves clear of dust, and though the oily tools would become coated after awhile, the pneumatic process kept the layer pretty thin and saved considerable time. If some of the small shop tool-makers would give us their experience it would be interesting and instructive, as it would be sure to bring out ingenious devices which are used to accomplish the desired operations with the few tools at hand. In a later paper I may tell how we made some of the tools used, and as we were obliged to make every dollar count, the tools were made as cheaply as possible and still do the work in good shape.

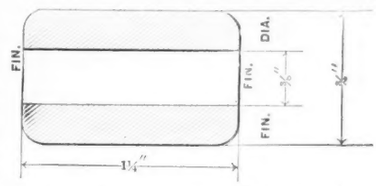
MACHINE DRAWINGS FOR THE SHOP.

ARTHUR B. BABBITT.

In the leading mechanical journals much space has been devoted to the above subject, yet, as in other departments of mechanical work, there is still a vast amount which can be said that might be of advantage to some careworn and weary draftsman.

A drawing is a graphical representation of a machine or parts of a machine, which must convey to the machinist, in the most concise manner possible, the amount of work to be done on the parts, in order that they may assemble properly. I say "in the most concise manner possible," because I believe that the machinist should be able to read the drawing without having to turn it upside down, do problems in addition and subtraction, and scale the blue print.

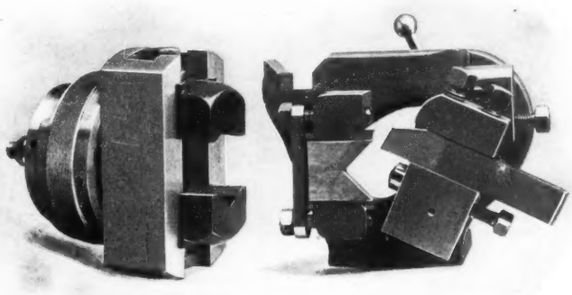
If the machine or attachment is of few parts, and an assembled drawing will illustrate every part, then a detail drawing is unnecessary; provided that the figures can be placed so that they will not interfere with an expeditious reading of the drawing. If there is any doubt that the assembled drawing will not show it clearly enough, then take the extra time and make the detailed drawings. An assembled drawing should always be used in conjunction with details, and where there are a number of parts which make confusion in the assembled, then an assembly of sections may be necessary. It is sometimes useful, in automatic machinery, to show an assembly of the parts used in each motion. As far as possible in making detail drawings, make the parts requiring lathe work, and those requiring planer work, on separate sheets; also make forgings and castings on separate sheets if possible.



Remember that extra time taken in the drawing room may save a little time in the machine shop, and where the drawings are to be used a number of times this saving multiplies. There is also a multiplication where time is saved in the drawing room and lost in the shop; but it is of a nature which cuts down profits. Practice economy in making drawings, but not that economy which shall be detrimental to its brother in the machine shop.

To denote the finished surfaces on a drawing, I have found that FIN. printed on the line to be finished illustrates clearly and can be made on the drawing quite rapidly. I designate finished diameters as follows:

Beside this method I have used the letter *f* on the line, also, the auxiliary line parallel to the line indicating the surface to be finished. In the first case the letter *f* is liable to be overlooked, or taken for something else, and in using the auxiliary line, it makes a confusion of lines on the drawing, which adds to the difficulty in reading it, even when the line is made in red on the blue print. This latter method also takes considerable time to execute, while the abbreviation FIN. takes but a short time to make in the drawing room, adds but slightly to the complication of the drawing, and works and wears well in the shop.



TAPER TURNING TOOLS.—SEE PAGE 176.

In titles, notes, etc., avoid using fancy letters, for in mechanical drawings I believe that a very plain type of mechanical letter should be used. Not that I believe a draftsman should be a machine, but that he should show his ability as an artist elsewhere on

the sheet. The figures on the drawings should also be of a very plain type, facing bottom and right of drawing, and dimension lines so placed that the figures will not come too close to the edge of the object. Always separate the numerator and denominator of a fraction by a horizontal line and never by an oblique. Pattern makers figures should never be put on a drawing that is to be used in the machine shop. Pencil drawings for the pattern makers will answer just as well as a finished drawing. When the drawings for the shop are not drawn to a small scale, an extra blue print should be taken and pattern makers figures placed on that, either by using soda water or white ink. When the working drawings are small, make (full size if possible) pencil drawings for pattern maker.

Different section lining should be used to represent different metals, so that, in assembly drawings showing sections, the metal used for the different parts may be readily seen.

Shading of drawings, and the angle of projection in which the drawing is made, are subjects which can be discussed until nothing more can be said; and yet, your antagonist in the discussion will believe the same as he did when you began. I prefer to use shade lines in assembly drawings, but not on detail work. I use the third angle of projection.

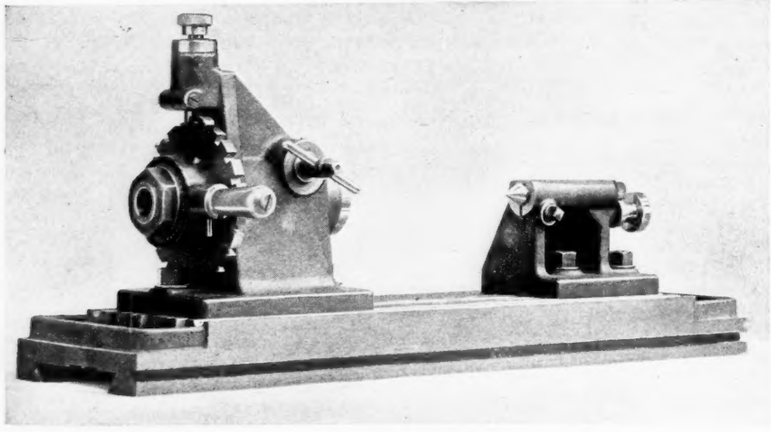
To obtain the best results from colored inks, use black for object lines, section lines, figures, indicating points, titles, notes, etc.; red for center lines, and green for dimension lines. The black prints the brightest, the red the faintest and green a good medium between the two.

The best size sheets to use are 12x18, 18x24 and 24x36; these make very convenient sizes in the shop and cut blue print paper advantageously. I use bond paper, making pencil drawing on this and inking same. I do not believe in making pencil drawings on one sheet and tracing. Tracing cloth should never be used, for it cannot be kept in good condition to get blue prints.

* * *

EIGHT-INCH SWING INDEX CENTERS.

These centers were designed for milling the teeth in sprocket wheels, but will be found useful for other purposes, such as milling taps, reamers, small gears, etc. The indexing is accomplished with one hand as the index bolt is withdrawn by the upward movement of the hand lever shown, and the spindle is revolved by the downward movement of same lever. The spindle hole is



EIGHT-INCH SWING INDEX CENTERS.

No. 10 Brown & Sharpe taper. The hole through it is $1\frac{1}{16}$ inch, beginning at back end of taper. The spindle can be firmly locked during cutting operations. Attention is called to the fact that by using single dials with just the number of divisions required, all mistakes in indexing are obviated. Single index dials are furnished with any number of divisions up to 24, and can be used on any milling machine having a tee slot in the table. For further particulars address, Kempsmith Machine Tool Co., Milwaukee, Wis.

* * *

MANY of the prominent technical men of Chicago, Ill., are endeavoring to found a Technical Club in that city, on somewhat the same lines as the engineers' clubs of New York and Philadelphia, to include engineers, architects, railway officials and representatives of allied interests.

THE RAILROAD FROM TIEN-TSIN TO SHAN-HAI-KUAN.

About seventeen years ago, there was in the whole Empire of China one short iron tramway ten miles in length. This tramway ran from Kaiping coal mines, which mines are eighty miles from Tien-Tsin to the sea. How long it had been built at that time, I do not know. The motive power of this railroad was man. The small cars were loaded with coal, pushed down to the sea, unloaded, and pushed back again. This work was done by coolies, who worked twelve and fourteen hours daily, and were paid ten cents (Mexican) a day.

At this time the works were put in charge of a young English engineer, who, restless, enthusiastic and modern, knew nothing of Chinese lethargy or the conservatism of their institutions. He ventured to propose many changed to facilitate the work and decrease the expenses. He was ignorant of Chinese superstitions of *feng shui*, and that his desired changes would, in the eyes of the Chinese, displease the spirits of air and water with the result of ruined crops and disastrous climatic disturbances. The authorities at Peking promptly vetoed his attempts at progressive measures.

Despite the Peking Government, there was one thing he would have, and that was a locomotive, and to have a locomotive was to build it himself. His workshop was a mat shed, and the tools at his command were few. Four small driving wheels were ordered from the United States, an old stationary engine furnished the boiler, and a broken-down winding engine the cylinders.

The "Rocket," as this engine was named, was a startling object to the Chinese as it flew over the track, with large yellow dragons emblazoned on its sides. Thus was made, owing to the determination and ingenuity of a young engineer as yet unimbued with oriental ideas, the first locomotive in China.

In due course the Peking Government heard of the innovation. Consternation reigned, and the Rocket dragon was ordered to be summarily suppressed. The Chinese director of the mines, however, permitted its use for short trips inside the yard, and gradually the length of its travels was extended. It was found that war, pestilence and famine did not follow, and that the *feng shui* of the locality was undisturbed by the iron steed. Imperial permission was at last granted for its free use.

This was the beginning of railroads in China, and the man who, seventeen years ago constructed the Chinese "Rocket," is to-day chief engineer and general manager of the imperial Chinese railroads. His name, familiar to all railroad men in America, is C. W. Kinder.—*Consular Report.*

* * *

CORROSION OF ALUMINUM.

The Yarrow aluminum torpedo boat has had but a brief career. Although it is but a short time since the vessel was floated, the metal has corroded to such a degree that it can be penetrated with slight pressure. M. Moissau has found that this corrosion is produced by the presence of a certain impurity in aluminum, each of three samples of aluminum examined by him containing a minute percentage of the metal sodium. This may be a discovery of the greatest importance in regard to the commercial development of aluminum, and one which at the same time accounts amply for the deteriorating effects of water upon this material.—*Industries and Iron.*

* * *

WE note with regret the announcement that *Industry* is to cease publication, with the possibility of renewing under new management. We have long admired the work of its editor, Mr. John Richards, whose ability and frankness have made his writings of great value. We shall miss *Industry* from our exchanges and wish both Mr. Richards and Mr. Bent prosperity in any field they may enter.

* * *

OUR English friends are having considerable fun over the effusion of Edison in the Sunday papers, as to his wonderful plans for annihilating our enemies. If he keeps on with such outbursts, the immortal Keely must look to his laurels.

MACHINE SHOP ARITHMETIC.

A series of practical articles clearly explaining the portions of mathematics which will be useful to the men in the shop and engine room.

PRACTICAL QUESTIONS CONNECTED WITH THIS SUBJECT WILL RECEIVE PROMPT ATTENTION.

FOUNDATION PRINCIPLES.

W. L. CHENEY.

To be thoroughly independent of *rules* for extracting roots (and a great many other mathematical calculations as well) we must consider the idea of *factors*.

When we multiply 3 by 2 we have 6 for a result, and we say 3 and 2 are *factors* of 6; multiplying again by 2 we get 12 and say that 6 and 2 are *factors* of 12, or we can say that 2 and 2 and 3 are factors of 12; or multiplying 12 by 12 we get 144 and say that 12 and 12 are factors of 144, or we can say that 2 and 2 and 2 and 2 and 3 and 3 are factors of 144, this being represented in arithmetical signs as follows:

$$2 \times 2 \times 2 \times 2 \times 3 \times 3 = 144$$

This is called an *equation* because something is represented as being *equal* to something else.

If we start and reverse the operation and divide 144 by 2 we have 72 as a result, and find that *one less* 2 on the left hand side will make the equation true, thus:

$$2 \times 2 \times 2 \times 3 \times 3 = 72$$

That is, we can take away one of the factors 2 from the left hand side of the equation and divide the right hand side by 2, and still have an *equation;* that is, one side will still be *equal* to the other side.

It follows then, that by taking one of the factors 2 from the left hand side, and dividing the right hand side by 2, we have done the same thing to both sides, because if we had not, they would no longer be equal.

That is, dividing 144 or any other number, by 2 or any other number, is simply taking the factor 2 (or whatever other number it may be), from the first number, no matter how the first number is represented.

Or in other words, taking the quantity $2 \times 2 \times 2 \times 2 \times 3 \times 3$ (which we happen to know is equal to 144) and removing one of the factors 2 from it, we have *divided* the *whole quantity* by 2.

A little more reasoning along this same line will show us that *dividing a factor by a certain number divides the whole quantity by that number*, or multiplying a factor by a certain number (or quantity) multiplies the whole quantity by that number (or quantity).

In arithmetic we can consider a certain number as representing a certain thing; that is, we can take the number 1, and consider that it stands for 1 ton of coal, and after going through our calculations, we know that the result, whatever it is, is also to be considered as tons of coal; so in algebra, a certain sign or letter may be considered as a certain number or quantity of anything and the sign or letter is multiplied or divided, etc., through the calculation, and when the calculation is completed, we know that this sign or letter represents in the result, the same thing that it did at the start: If we say that a represents a ton of coal, and when the calculation is completed, we have a result of 144 a, we know that this means 144 tons of coal.

It would be easy enough to carry the number 1 through any calculation (no matter now whether 1 ton of coal or 1 something else), but if we had the number 1,083,729,524,982 to deal with, it would be quite a task to carry it through a long calculation, and a slight knowledge of algebra allows us to consider that a, or b, or c represents this large number, or any other number or thing, and carry the *letter* through a calculation (it is *customary* to use the first letters of the alphabet to represent *known* quantities, and the last letters of the alphabet to represent *unknown* quantities, but it is not necessary to follow this custom, as we can as well use a picture of a ton of coal to represent the ton of coal, or the above number of tons of coal, if we only stick to the same thing until the calculation is finished).

If then, we had a large number like the above to deal with, it would evidently be easier to say in starting:

$$a = 1{,}083{,}729{,}524{,}982,$$

and take the a through the calculation; then if, for instance, we got 3 a as the result of the calculation, we would know that 3 times 1,083,729,524,982 was our answer, thus being obliged to multiply this large number but once in the whole calculation, which reduces the chances or error, as well as being easier and quicker.

In algebra, contrary to arithmetic, the position to the right or left, of a letter or sign, has nothing to do with its value, and two or more letters side by side means that these letters are *multiplied together*, or, in other words, that they are *factors*.

The expression "$a\,a$" then, means that a, whatever it represents, is multiplied by a, and if we assume that a represents 12, we then know that $a\,a$ represents 144.

But as any quantity multiplied by itself becomes a *square*, the expression "$a\,a$" is evidently equivalent to the expression "a square," and for the same reason the expression "$a\,a\,a$" is also evidently equivalent to the expression "a cube."

It is easier and quicker (besides being customary) to write a square thus, a^2 instead of "$a\,a$," and a cube, a^3 instead of "$a\,a\,a$." When this is understood we can take another step, and instead of saying $a = 12$ we can say $a = 10$ and $b = 2$, then we can go ahead and say a plus $b = 12$, or using the regular arithmetical sign for plus (addition) we write it thus:

$$a + b = 12.$$

It then follows that $a + b$ multiplied by itself will be equal to 12 multiplied by itself, or in other words that $a + b$, square, is equal to 12 square, and that (knowing 12 square to be 144) $a + b$, square, is equal to 144.

We can now multiply the expression $a + b$ by itself, the operation being very much like multiplication of numbers in arithmetic. First (as in arithmetic) we set the quantities to be multiplied one under the other, thus:

$$\begin{array}{r} a+b \\ a+b \\ \hline \end{array}$$

b multiplied by b will evidently (from what has already been explained) become b square, written b^2, so that after the result of this first step is written down, the calculation would appear thus:

$$\begin{array}{r} a+b \\ a+b \\ \hline b^2 \end{array}$$

Multiplying a by b would give us $a\,b$, which we also set under the line, same as in arithmetic, thus:

$$\begin{array}{r} a+b \\ a+b \\ \hline a\,b+b^2 \end{array}$$

we have now multiplied $a + b$ by b and must start to multiply $a + b$ by a as follows: b multiplied by a is evidently $a\,b$ (the *position* of the factors not altering their value, so for convenience in adding we write it $a\,b$ instead of $b\,a$), so (also for convenience in adding) we set this $a\,b$ under the other $a\,b$ which we get at first by multiplying a by b, thus:

$$\begin{array}{r} a+b \\ a+b \\ \hline a\,b+b^2 \\ a\,b \end{array}$$

And a multiplied by a is evidently a^2, which we also set down thus:

$$\begin{array}{r} a+b \\ a+b \\ \hline a\,b+b^2 \\ a^2+a\,b \end{array}$$

We now (same as in arithmetic) add the results of multiplication together for the answer: $a\,b$ added to $a\,b$ is evidently *two* $a\,b$,

which is written "2 *a b*," so that the complete operation now appears thus:

$$\begin{array}{r} a+b \\ a+b \\ \hline ab+b^2 \\ a^2+ab \\ \hline a^2+2ab+b^2 \end{array}$$

$a^2+2ab+b^2$ and $a^2+2ab+b^2$ is the formula given in the article on "square root" in a former number.

By multiplying this again by $a+b$, we will evidently get the *cube* of $a+b$, which is the formula used in the article on cube root, thus:

$$\begin{array}{r} a^2+2ab+b^2 \\ a+b \\ \hline a^2b+2ab^2+b^3 \\ a^3+2a^2b+ab^2 \\ \hline a^3+3a^2b+3ab^2+b^3 \end{array}$$

If we should multiply this again by $a b$, we should get a formula which would allow us to extract the *fourth* root, and so on.

A thorough understanding of these foundation principles, and of the previous articles on square root and cube root, makes us independent of any written rules for extracting square, cube, or *any other* root.

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

29. T. B. O., Fiskdale, Mass., asks: 1. What is meant by saying "the high pressure had eight expansions and the low pressure ten," and similar expressions. *A*. The number of expansions can, perhaps, be best explained by taking the case of a cylinder which is 24 inches long (the dimaeter does not matter, as it is practically the same the entire length of the stroke), and assuming that we cut off the steam after the piston has traveled 3 inches of its stroke, or ⅛th of the 24 inches. The steam expands as the piston advances, until at 6 inches of the stroke it is twice the volume it was at point of cut-off, that is, at 3 inches. At 12 inches, or ½ stroke, the steam occupies 4 times the original space, and at 24 inches, or full stroke, it occupies (24 ÷ 3) 8 times the original volume at cut-off. So we see that when we cut off at ⅛th of the stroke we have 8 expansions, at ¼ stroke, 4 expansions, etc. This is not exactly correct, as it does not take into account the steam in the ports and end clearance of the cylinder. This steam must be added to that in the bore of the cylinder included in the 3 inches of the stroke and reduces actual expansion. As, calling the clearance equal to 1 inch of the cylinder bore, or $\frac{1}{24}$th of the cylinder volume, we have 3 + 1 = 4 inches as the actual point of cut-off instead of 3 inches, and the actual number of expansions would be 24 ÷ 4 = 6 instead of 8. It may be well to add that, theoretically at least, the pressure decreases in direct proportion to the expansion. Again neglecting clearance for simplicity, and with a pressure of 90 pounds maintained until cut-off at 3 inches. When the piston reaches the 6 inch point the steam occupies *twice* the volume it did at 3 inches and the steam drops to *one-half* the pressure, or 45 pounds; at 9 inches the volume is *three* times and the pressure *one-third* of 90, or 30 pounds, and so on until with 8 expansions the pressure would be 90 ÷ 8 = 11.25 pounds, or allowing for clearance and calling it 6 expansions, 90 ÷ 6 = 15 pounds terminal pressure.

30. F. W. S., Chicago, Ill., writes in regard to formula for spiral springs, page 122, and asks if a helical spring is not meant? *A*. The term spiral is very often, we might say generally, used, probably because the genuine spiral is rarely used in machine construction. Helical is the correct term and should have been used, the fact that they were called "spiral" in the book referred to accounting for its use.

31. J. Y. M., Richmond, Va., asks: Can it be proven that if the bisectors of the base angles of a triangle are of equal length, the triangle is isosceles? *A*. As an isosceles triangle is one which has two sides equal, as in Fig. 1, where the sides A B and A C are equal. The base angles are B and C, and bisecting these by the well known method of striking any arcs as F G and H I, then with F, G, H, and I as centers and with any distance *more than half* from F to G or H to I as shown, and drawing lines from B

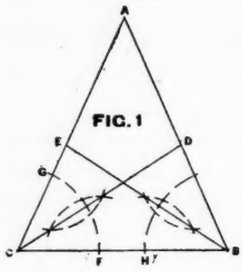


FIG. 1.

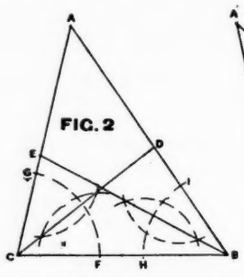


FIG. 2.

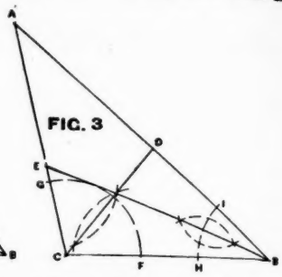
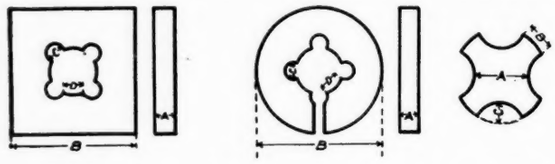


FIG. 3.

and C through these points we have B E and C D as the bisectors of the base angles, we find they are of equal length. In Figs. 2 and 3 we have triangles which have no equal sides and which are called scalene triangles. Bisecting the base angles by same methods as before we find the bisectors are unequal, which shows that no two of the sides (and consequently no two of the angles) are equal. In the case of an equilateral triangle, we have the same condition regarding the base angles as in the isosceles triangle, and the bisectors of the base angles will be equal without the triangle being an isosceles. So we can prove that, when the *base angles* are equal, their bisectors will also be equal, and it also follows that this occurs regardless of whether the other angle is equal to the base angles or not, or whether the base is equal to the other sides or not.

32. E. T., Philadelphia, Pa., asks: How do you proportion taps and dies. Taking enclosed sketches, what should each dimension be in proportion to size of tap? *A*. While much depends upon conditions and practice varies, the best ideas can, perhaps, be obtained by observing those made by regular makers. For brass work the portion D of the die (B of tap) must be greater than for iron or steel, as the thread needs more of a guide in the brass than in iron. About one-third of the circumference has been found good practice for brass work, while for iron from one-fourth



to one-fifth has been used with success, still there is no cast iron rule to be laid down. The clearance C should be enough to get rid of chips and allow grinding, one-fifth the diameter will give very good results. Diameter and thickness of die depend on how they are to be held while in use, one size holder usually answering for several sizes of dies. Thickness can be called equal to internal diameter of die until we reach half inch or possibly three-quarters; above this the thickness increases very slowly and few dies, unless very large, exceed an inch in thickness.

33. N. M. E. G., Delaware County, Pa., asks: 1. Taking an engine 12x18 inches, cut-off at ½ stroke, clearance 7 per cent., steam pressure 150 pounds absolute, piston speed 350 feet per minute. 1. What is HP. of engine? *A*. As 7 per cent. of stroke is 1.26 inches we have $\frac{18+1.26}{9+1.26} = 1.87$ as actual expansion. Hyperbolic logarithm of 1.87 = .6259, then M. E. P. $= \frac{1.6259 \times 150}{1.87} = 130.4$ lbs.

$$\text{HP.} = \frac{\text{mean effective pressure} \times \text{piston speed} \times \text{area of cylinder}}{33{,}000}$$

or, $\frac{130.4 \times 350 \times 113.098}{33{,}000} = 156.41$. 2. What is quantity of water required from boiler per HP. hour? *A*. As steam is cut-off at 10.26 inches the steam per stroke will be the area × 10.26 or 113.098 × 10.26 = 1160.38 cubic inches = .67 of a cubic foot. A cubic foot of steam at 150 pounds pressure weighs .3377 pounds and one stroke takes .3377 × .67 = .226 pounds. At 350 feet piston speed the engine must make (18 × 2 = 36 inches or 3 feet, 350 ÷ 3) 116.6 revolutions per minute or 233.2 strokes, then 233.2 × .226 = 52.7 pounds per minute for the engine. Multiplying by 60 to get weight of steam per hour and dividing by HP. we get 20.2 pounds of water per HP. hour. 3. What is volume of steam in cubic feet per hour per HP? *A*. The volume of 20.2 pounds of steam at 150

pounds pressure is 20.2×2.96 (the volume of 1 pound at this pressure = 59.792 cubic feet. 4, Total number of heat units per hour? *A.* Taking 1223.2 as the total number of heat units in 1 pound of steam at 150 pounds pressure, we multiply this by the total weight of steam used per hour. Or, $20.2 \times 156.41 \times 1223.2 = 3,864,678.3824$ heat units per hour.

34, J. T. W., Waterbury, Conn., asks: What takes place in a piece of steel when heated properly and plunged into cold water; why does it harden? *A.* There is probably no thoroughly satisfactory answer to this question, most authorities admitting that they do not know. We submitted this to one whom we consider an expert in steel and its working and, while not wishing to be quoted, he says:

"If the correspondent had asked why iron does not harden we should say, lack of carbon, likewise owing to the amount of carbon and other ores or constituents; steel hardens, as a natural consequence, a line of demarkation between iron. As we enter into the field of tool steel we have ores and higher points of carbon connected together as a dense mass, the more dense it is the quicker (or at a lower heat) it hardens.

"The action of steel in hardening is a sudden contracting, bringing all the minute particles of carbon together in a state of crystallization. In air hardening steel the ore is of such a nature that, combined with a high percentage of carbon, it requires but the natural cooling down to bring together into a dense mass the whole structure.

"This is a very odd question tc answer and I do not wish to be quoted, but I am sure my theory is right although roughly explained."

35. Engineer asks: How do you compute heating surface of a boiler? *A.* Heating surface may be designated as any surface which has water on one side and heat on the other. With an ordinary horizontal return tubular boiler it is customary to count two-thirds of the circumference of the shell exposed to the fire and the area of the return tubes. While there is a difference of opinion as to which surface of tubes should be used, it seems rational to use which ever is in contact with the water; this being the outside in the boiler referred to and inside the tubes of a water tube boiler. For a horizontal boiler the usual allowance is from 12 to 15 square feet per HP.

36. K. T. T. Your questions relating to foundry practice can best be answered by referring you to "The Encyclopædia of Founding," by Simpson Bolland, which costs $3.00.

* * *

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

DRAWINGS FOR THE SHOP.

In a recent example of shop drawings, published in a Guide for Mechanics and Draftsmen (see page 3 of your issue for September, 1895) I notice some very glaring faults in minor matters.

In the first place the dimension-numbers are so badly made that many of them are nearly indistinguishable. It is true that the original has been reduced from 14 inches × 18 inches to about 4½ inches by something or other; but it must be remembered that to the sight of many workmen who have not their glasses on, they are blurred, and to many near-sighted persons who have on concave glasses they appear as small as they seem, on the printed page mentioned, to persons with normal vision. Some of the sixes look like o's; some of the nines ditto. There is a $1\frac{11}{32}$ in the upper left-hand corner which might be $1\frac{31}{32}$ with a very little imagination or very trifling visual defect (and perhaps it really is $1\frac{31}{32}$ and looks like $1\frac{11}{32}$!)

Introduction of hyphens or short dashes between words, and drawing lines under them, makes them less legible than if they were not separated and underscored; and the lines of capitals are not so distinct as "upper and lower case" would be. The example shows mongrel lettering and numbering, although the text calls for "full-face Gothic."

I think that draftsmen, pattern makers and machinists prefer "dot and dash" center-lines to the full ones given in the sample drawing. Full lines for outlines of visible parts, dotted lines for parts back of those which are seen, "dot and dash" lines for centers, and broken lines for long dimension-lines, seem to have been accepted by most draftsmen, and to be understood by most machinists, blacksmiths and pattern-makers the world over; and as the growing use of the blue-print for shop use precludes very largely the employment of color, solid red for center-lines and various tints to represent various materials seem obsolete practice. The Pennsylvania Railroad and many other establishments have standard hatchings to represent certain materials; and it is to be regretted that there is no uniformity in this usage.

Philadelphia, Pa. ROBERT GRIMSHAW.

TIGHTENING METAL COLLARS.

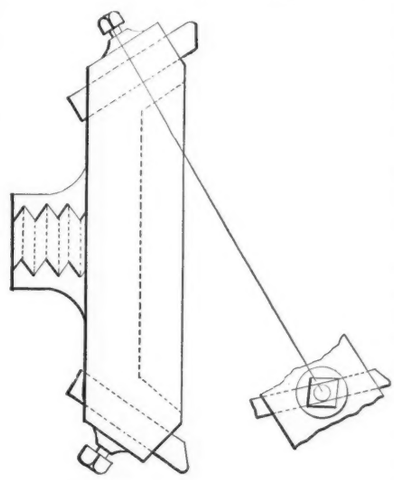
"It sometimes occurs that rings or sleeves shrunk on hot metal turn out to be loose. According to a note in the *Deutsche Techniker Zeitung*, the mishap can be remedied in a simple manner, which may not be generally known. The collar or sleeve is heated to a bright red, and placed into a shallow basin filled with cold water, so that only half of the flat ring lies in the water, where it is allowed to cool. It will be found that the ring has become conical, that part which *was not in the water* being contracted. The process may be repeated several times, the halves being immersed alternately. The same operation is reported to answer for the eyes of levers, cranks, etc."

The above is clipped from an English paper, the italics are mine. Now if my experience and theory count for anything, the part *in the water* will be found smaller; in fact, this method has been used quite successfully in several cases I know of.

Hoboken, N. J. "CONTRACTED."

SUGGESTION FOR MILLING CUTTER.

In answer to the request for a cheap milling cutter of fairly large diameter, I would suggest one like the enclosed sketch.



Have the body of cast iron and insert the cutters as shown, holding by set screws. This enables the cutters to be advanced to maintain required diameter, which would be difficult if they were parallel with the axis of the machine. There are cases where it might be well to have the cutters adjusted forward by a set screw, but for ordinary work this is not necessary. If the cutters are removed for grinding, they can be replaced very accurately by a gage of sheet steel. As it is not always easy to make square holes through the rim for cutters, there will be no harm in using round holes, drilled large enough for the steel "across the corners." The square corners of the cutter, efficiently aided by the set screw, give the cutters a lead of about 15 degrees, as shown in the little sketch of top view, and the cutting will be free without grinding the face in the least.

Hope to hear from others on this subject and in turn will ask for a follower rest, that will follow the straight and narrow path of the lathe centers and *not* all the variations of the work.

Camden, N. J. R. E. MARKS.

NOTES FROM THE WORTHINGTON SHOPS.

In addition to your article in the last issue it may be interesting to know that the rotary planer is run by 15 HP. motor, running about 32 feet per minute, feed from 1 inch to 4 inches per revolution. The milling machines run about 45 feet per minute. One large tool, not shown, is a 120 inch lathe, which is double and bores two cylinders and valve chests at same time—at times having ten tools cutting at once. The large beam drill bores and taps up to ten inches in diameter. H. R. W.

Brooklyn, N. Y.

ROPE DRIVING AND GEARS.

In answer to the question by Mr. S. Webber in the December number of your paper asking what I mean by 1,500 pounds per square inch would say, that what is meant is the resulting tensile stress in the extreme layers of metal, in the wheel-tooth at the root or base when load is applied at the point. This stress may

seem low to him and in fact is so, for a wheel running at 1,570 feet at pitch line per minute when subject to little or no shock. But as I usually have to deal with rolling-mill machinery, I naturally calculated a wheel strong enough for such service, in which the pressure on teeth will often considerably exceed that due to the engine effort, by having to transmit part of the stored energy in flywheel.

For mill work I have found from wheels that gave good satisfaction, 1,500 pounds per square inch to be a fair allowance for that speed. If, however, I should make calculations for a wheel subject to little or no shock, running at the same speed as given above, I would not hesitate to allow from 2,500–3,000 pounds per square inch, and for slow moving gearing, where power is transmitted by belts, up to 5,000 pounds per square inch. This is my opinion about strength of gearing.

To give Mr. Webber some data, I have arranged a table giving examples from practice.

	No. of HP. Transm.	Pitch, inches.	Width of Face.	Velocity in Feet per sec.	Tensile Stress per sq. inch.	Pressure per inch of Face.	Source.
No. 1	1,000	5.25	24	38.37	1,877	580	Konstrukteur by Reuleaux. Unwin's "Machine Design." Recom. by S. Webber. J. L. Klindw.
No. 2	300	4.00	14	31.82	1,565	375	
No. 3	270	6.22	20.7	10.28	1,850	692	
No. 4	1,400	5.23	24	56.50	1,820	567	
No. 5	570	5.18	18	72.00	783	242	
No. 6	400	4.02	18	51.5	950	237	
No. 7	400	4.00	10	26.2	3,278	840	
No. 8	400	5.75	17	26.2	1.270	435	

Nos. 1, 2 and 3 were taken from "Konstrukteur," 4th German edition, page 590. Nos. 4 5 and 6 from "Unwin's Machine Design," Vol. II., page 172. In most all cases the teeth were secured to the rim of flywheels and were subject to but little shock. They gave good satisfaction. The stress was calculated by formula (4*a*), see October issue. If Mr. Webber will refer to table and consider what was said above, he must admit that I am not "altogether wrong"; yet I would not say that he is "altogether wrong," because for certain work his wheel would be strong enough. I do think, however, that the pressure per inch of face is too great for wear. The strength of a gear is, of course, the first requisite, but the wearing quality is certainly a close second; for to replace a wheel of considerable size means quite a little sum of money, besides the time lost in placing the wheel in position. When making calculations for pitch, etc., of a gear, the designer should consider well several points, for instance (1) the kind of work the wheel is to do; (2) under what conditions such work will be done; (3) will it be driven by engine or by belt; (4) what part of the maximum work will the mean work be, etc., and then decide upon the safe stress per square inch of material. For ordinary gearing Prof. Reuleaux determines the safe stress by the following formula:

$$\text{Safe tensile stress} = \frac{160{,}000}{\text{vel} + 36}$$

Stress taken in pounds and velocity in feet per second. For steel, multiply by 3½ and for wood by 0 6. This is rather high for steel.

Pittsburgh, Pa. J. L. KLINDWORTH.

A NEW REVERSING GEAR.

Enclosed please find blue print of a reversing gear I invented some time ago.

Realizing that it will be a hard task for me to find a manufacturer liberal enough to make a reasonable offer for the device and having no time nor taste for such a pursuit, I have decided to give it to the public, fearing to throw it into the scrap basket some day. Should any of your readers find it interesting, I do hereby authorize them to take advantage and use whatever novel or useful feature may be incorporated in it.

The object of said invention is to obtain a reverse motion, using a single open belt operating a cone pulley, doing away with the annoying *shifting* and enabling the operator to change the speed and the direction of the machine with the belt running. It is intended for use on planers, shapers, rolling-mills, belt elevators, hoisting machines, etc.

By referring to the drawing very little explanation will be necessary. Fig. 1 shows a spur and annular gear combined in one piece, two pinions, and the rack of a planer. The gear and pinions are shown again in a plan view, partially in section, in Fig. 2. One of the pinions runs loosely while the other one is driving, or both pinions might be running loosely, in which case the large gear is at a stand still.

In Fig. 2 are shown friction couplings sliding on feathers, but positive clutches as shown in Fig. 3 might be used.

Fig. 5 shows clutches of the face ratchet type (both disengaged).

Fig. 4 shows the dog or clappet on table of planer, to throw the couplings into gear by means of the lever *h*, in Figs 2, 4 and 5.

Fig. 7 is a pneumatic plunger working in the body of the planer dog to prevent jarring or sudden motions if the positive clutches are employed; *p*, in Fig. 7 represents a section through the body of the dog.

Fig. 8 is an enlarged view of the teeth used on the positive clutches.

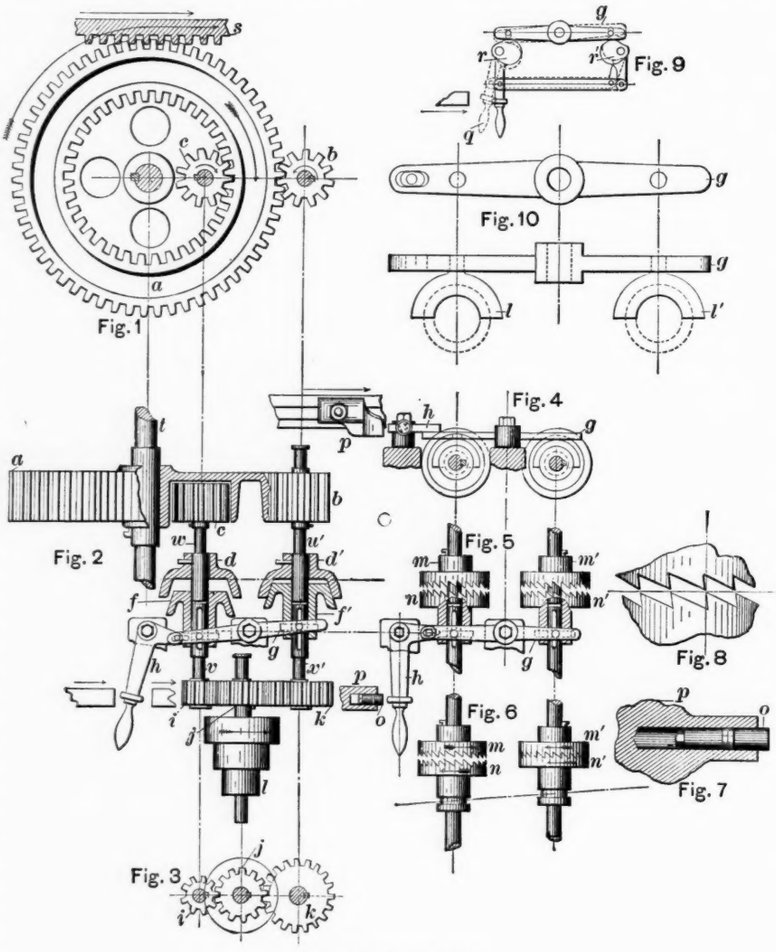
Fig. 10 is an enlarged view of lever, *g*, in Figs. 2, 4 and 5, and Fig. 9 is another system of levers using eccentrics to throw the couplings into gear.

It is obvious that any ratio might be given to the return or empty motion of the train, and that the speed as well as the stroke can be changed while running. The platen can be stopped at any length of the stroke without arresting the belt and the throwing into gear can be done by hand or automatically, or both.

I have some other inventions which will be sent to you for publication, as the craze of inventing for the sake of inventing, is over with me, and as I have said before, I am afraid to throw all those drawings to the scrap basket.

JUAN DE D. TEJADA.

Coxsackie, N. Y. The Kennedy Valve Mfg. Co,



A NEW REVERSING GEAR.

MORE ABOUT THAT BELL CHUCK.

In the January issue, George B. Woodruff asks about how the ring B is forced on the split nut A, referring to the cuts showing a bell chuck in the issue for November.

A moment's thought will show Mr. Woodruff that every time the chuck is taken off the lathe the nut is taken off also. Before it is put on again the ring is driven on the nut by slamming the two down on a block. This compresses the nut, which was compressed in the same way before being threaded to fit the spindle.

J E. S.

HYDRAULIC CYLINDERS.

In your next issue will you kindly take up the subject of "strength of hydraulic cylinders in cast iron and cast steel for both thin and thick shells"? A. B. C.

Akron, Ohio.

[We should like to have the experience of some of our readers on this subject. ED.]

THE SPRING GARDEN INSTITUTE SCHOOLS.

Referring to item in your January issue (page 156) regarding Spring Garden Institute Schools, I wish to say that I submitted the proof of my paper in *Engineering Magazine* to Mr. Addison Burk, president of that institution, with request that he would correct any possible mistake regarding the early work and history of the institution; he returned the proof with a note saying it was quite correct. Furthermore, in October, 1895, an account of the Spring Garden Institute appeared in the *Ledger*, written, I believe, by Mr. Burk, who is the assistant editor, and it was from that article that I obtained my information regarding Lieut. Crawford. Dr. Grimshaw's name did not appear in Mr. Burk's paper, and I was ignorant of his early connection with the institution.

Philadelphia, Pa. ALEX. E. OUTERBRIDGE, JR.

[We believe Mr. Outerbridge took every possible precaution, and that the apparent misstatement was no fault of his.—ED.]

A MATTER OF STATISTICS.

I wish to appeal to you in a matter of statistics. A locomotive, we will say, makes a yearly mileage run of 36,000 miles at a cost of six cents per mile for its maintenance. Naming $10,000 as the engine's first cost, the amount thus required annually to be set apart as a sinking fund for the machine's perpetuating, is 21 per cent. of its first cost. Now, does machinery for any other purpose, operating under due conditions of stability and cleanliness, involve for its maintenance anywhere near a like percentage? Is it not due to operating on such uneven and unstable foundations and amid such clouds of dust in dry weather and showers of mud in wet seasons that the per cent. of the cost of the rolling plant of a railroad annually is so high? Every consideration implies an affirmative answer, and in order to know how much of the earnings of a road may wisely be expended in removing the exciting causes of ill, it is needed to know the difference between the annual per cent. of cost that is required for repairs of machinery environed as is that of a railroad, and that which is not so environed.

Financially this difference is the only fund which may be legitimately used in obviating the causes complained of, and it is important that its extent be known. The question then is, what annual per cent. of first cost does machinery of any kind or kinds, other than the railroad's rolling plant, require for their maintenance.

If any of your contributors can answer this as to any kind of a plant, or refer me to authorities who can, I shall be under great obligations. JOSEPH ANTHONY.

Los Angeles. Cal.

BROTHERLY LOVE.

We sincerely regret to learn that the printing office of our esteemed contemporary, the *Western Electrician*, was burned out on Monday of this week. The issue of the paper for the current week may be slightly delayed. The hustling abilities of our Western friends will doubtless be equal to the emergency. With such a valid excuse, even a week's delay in the delivery of the *Western Electrician* would be pardoned by its readers. But the Postal Telegraph Building at 253 Broadway, New York city, still stands—and yet the *Electrical World* for last week has not been issued as we go to press. Has our tea-green contemporary at last taken pity on its few paying subscribers and allowed them a temporary respite?—*Electrical Review*, Jan. 8.

* * *

THE first annual meeting of the National Association of Manufacturers was held at Chicago, Ill., on January 21st. We go to press too early to give details, but knowing the men who are prominent in the movement, Thomas Dolan, being president; Robert Laidlaw, treasurer; E. P. Wilson, secretary, and with such men as Warner Miller and Thomas P. Egan on the executive committee, it is safe to say that the interests of manufacturers will be well looked after.

* * *

MANUFACTURING NOTES.

MR. WILLIAM LODGE, the founder of The Lodge & Davis Machine Tool Co., has sold his entire interest in that company and will hereafter devote his exclusive attention to The Lodge & Shipley Machine Tool Co., of Cincinnati, O., who manufacture a line of engine lathes from 12 inches to 42 inches, and also chucking lathes from 12 inches to 48 inches, 16 inch and 22 inch screw machines, and have recently brought out a massive screw and bicycle hub machine weighing 4,500 pounds and taking 2⅞ inch stock through the wire feed. The Lodge & Shipley Machine Tool Co. are running their plant until 10 P. M. every night, and are crowded with orders sufficient to keep running for several months to come.

THE DIAMOND MACHINE CO., of Providence, R. I., has recently moved its department for the manufacture of leather covered wood polishing wheels into a new building, especially built and adapted to this purpose, thereby more than doubling their capacity for the manufacture of these goods. This move has been necessitated by the increased demand for wooden wheels, recent orders having been booked for 500 wheels from one firm and 400 from another.

DAVIS & EGAN MACHINE TOOL CO.

REORGANIZATION OF THE LODGE & DAVIS MACHINE TOOL CO.

It was recorded in these columns lately that Mr. Charles Davis, President of the Lodge & Davis Machine Tool Co.; Mr. Thomas P. Egan, President of the J. A. Fay & Egan Co.; Mr. Robert Laidlaw, President of the Laidlaw-Dunn-Gordon Co. and Mr. Thomas McDougal, had purchased the entire stock held by the Lodge interest in the above company. Mr. Charles Davis and Mr. Thomas P. Egan are now in Chicago for the purpose of combining the large interests operated by each company in that city. They have heretofore been strong competitors, and operated the two largest machinery houses in Chicago. Their stores in other cities will also be combined at an early date. The consolidation of these three companies form one of the strongest concerns in the world. The joint companies now employ over 2,000 men.

The Davis & Egan Machine Tool Co. will continue to manufacture a high grade of tools for the production of locomotives and stationary engines, electric dynamos and motors, sewing machines, bicycles, mining and agricultural machinery, woodworking machinery, steam pumps, printing presses, etc. They propose to increase the capacity of their plant largely and to add such new lines of machine tools as will enable them to furnish the entire shop equipment from the smallest to the largest machines. Their works are being operated day and night, and an additional force of 75 men will be put on in the next ten days.

The new company controls unlimited capital, has no indebtedness or preferred stock and will rank as one of Cincinnati's leading industries.

The officers of the company are: Charles Davis, President; W. H. Burtner, Vice President; B. B. Quillen, Secretary.

A MODEL TRAIN.

NEW YORK AND FLORIDA SHORT LINE LIMITED.

Commencing Sunday, January 5th, and daily thereafter the popular New York and Florida Short Line Limited will be resumed between New York and St. Augustine, via Pennsylvania, Southern and Florida Central and Peninsular, leaving New York at 3.20 P. M. The train will be composed of Pullman's latest compartment cars, sleeping, dining, first-class coach and smoking cars, from New York to St. Augustine. For grandeur and solid comfort there is nothing in the world that surpasses this train. The compartment car is a model of perfection. The entire train is most elaborately furnished, and the country through which the train travels is rich in magnificent scenery, and the one day which is consumed in the trip can be spent most advantageously in taking in the beauties of nature. The announcement of the new train several years ago was one of the great achievements of the Southern Railway "Piedmont Air Line," and the public are highly grateful and have and will continue to show their appreciation to the evident satisfaction of those instrumental in reducing the time between New York and Florida to a minimum. Excursion tickets south have been placed on sale at very low rates, and those contemplating taking a trip to the Sunny Lands should call on or address R. D. Carpenter, General Agent. Alex. S. Thweatt, Eastern Passenger Agent, 271 Broadway, New York.

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FRESH FROM THE PRESS.

THE WATERBURY FARREL FOUNDRY AND MACHINE CO., Waterbury, Conn., continue issuing their monthly booklet containing cuts and brief descriptions of their various machines. This month's contains 108 machines in addition to a separate circular of a Double Acting Forming Press.

BEAMAN & SMITH, Providence, R. I., have issued catalog D, a neat

little book of over 60 pages, containing illustrations and descriptions of the tools built by them. They are mostly boring, drilling and milling machinery, although lathes are also shown and built. They make a line of safety drill and tap holders which are money savers in almost any shop.

EDWIN HARRINGTON, SON & CO., Pennsylvania avenue and 16th street, Philadelphia. Pa., send their new catalog showing the improved features of the Harrington hoist, which has long been known as one of the best on the market. Among the improvements are the substitution of bronze for iron worm gears, square holes and hubs instead of clutches and improved housings for the worm and gear to protect from dirt and retain oil. A novel feature is the combined hoist and electric motor, which will make a very compact and desirable addition to any shop.

THE NEW BRITAIN MACHINE CO., New Britain, Conn., send us a catalog of their new Chain Saw Mortiser, one of the novelties of the woodworking trade. The arrangement can be likened to a chain belt, each link having a tooth on the outer edge. This runs over roller bearing sprockets, and the work is rapidly and neatly done. All interested should secure a catalog.

THE PENBERTHY INJECTOR CO. issue a calendar from their publication department which will be found on many walls till the end of the year. It is novel in having the months in two pads instead of one, so that one can always see into the next month without turning any leaves. It may not be generally known that this company has a complete printing office for the publication of its advertising matter, but such is the case and the calendar shows the good quality of work turned out.

THE DIAMOND MACHINE CO'S., Providence, R. I., catalog No. 15 contains 64 pages devoted to the various grinding machines of their manufacture. The line is very complete, including grinders for nearly all purposes, from grinding lathe centers to automatic knife grinders and large surface grinders. Any one who has grinding to do, and there are few who have not, will do well to become familiar with the many good points of the Diamond machines, as they contain numerous special features to be had in no other machines.

THE ATHOL MACHINE CO., Athol, Mass., have issued their 1896 catalog which includes the products of the Standard Tool Co., also of Athol. The list includes meat choppers, grindstone frames, animal tethers and the Simpson vise in a variety of forms; also ordinary vises for shop and home use. The machinists' tools of the Standard Tool Co. are well known and include their latest products, the key-ring screw gage among the number. Shop managers and machinists should secure a copy of the catalog.

THE WORKSHOP MANUAL. Compiled by John J. Davis. 248 pages. The American Artisan Press, Chicago, Ill. Price not given. This is a compendium of useful information for sheet metal workers and mechanics of all kinds. It is divided into nine chapters and in each the subjects are alphabetically arranged, which facilitates finding the desired information. One chapter is called workshop receipts; others are on pattern cutting, which is valuable for sheet metal workers; tables of various kinds are given, some of which seem odd in such a book, but many of them are useful. There is enough in the book to interest almost any mechanic, and if the price is not too high it should have quite a sale.

THE HINE & ROBERTSON CO., 80 Cortland St., New York City, have issued a neat 20 page catalog of a handy size for the engineers pocket. The advantages of the Robertson-Thompson indicator are fully shown and their other specialties are also illustrated so as to attract attention; among them are the standard Planimeter, Victor Aluminum Reducing Wheel, Indicator cocks, the Junior Indicator, Inspectors gage testing outfit, damper regulators, etc., etc. A copy will be sent on application.

LETTERING FOR DRAFTSMEN, ENGINEERS AND STUDENTS. Charles W. Reinhardt. Price, $1.00. D. Van Nostrand Co., New York. This is a practical system of freehand lettering for working drawings by the chief draftsman of the *Engineering News*. It is substantially bound and has 24 pages of heavy plate paper, 8x11 inches, and nine plates for "copy," showing the different styles of letters used. The intention is to illustrate and describe a type of lettering that looks well on working drawings, is simple in form, is rapidly made and is clear and distinct under reduction by photography. There is no attempt at fancy lettering, but almost any draftsman who wishes to acquire a neat style of clear and a pid lettering, the only useful kind, will appreciate the book.

No. 18 of the FOUR TRACK SERIES is entitled "New York as a Winter Resort," and is a handy 64 page booklet just issued by the passenger department of the New York Central R. R. It has an original map of New York City, in colors, which will greatly aid a stranger in going about the city, and there is a list of nearly all the hotels in New York, together with theaters, concert halls, notable restaurants and stores. The map shows the advantage of landing at the Grand Central Station, in the heart of the city, and the time required to reach all the theaters is given in the list. The booklet is attractively illustrated, and can be had by sending two 2-cent stamps to Geo. H. Daniels, Grand Central Station, New York City.

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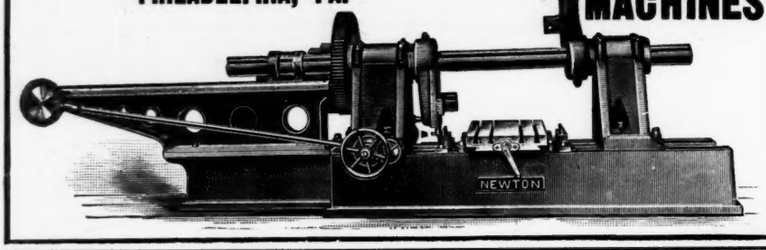

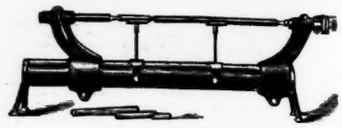

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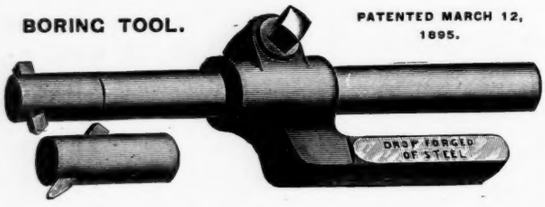

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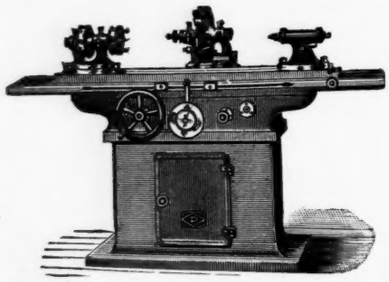

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